Journal of
CHRONIC
DISEASES

VOLUME 13 . NUMBER 6

JUNE, 1961

ol. 13
1961

Symposium

ORTHOPEDIC PROBLEMS IN MEDICAL PRACTICE

Special Editors
ALLEN F. VOSHELL, M.D.,
AND J. VERNON LUCK, M.D.

INTRODUCTION

The Editors of the JOURNAL OF CHRONIC DISEASES desired to present to the readers of this JOURNAL information relating to orthopedic surgery and asked the below named orthopedic surgeons to act as guest editors. In turn we solicited a number of our colleagues to submit material in line with their special interests and efforts, with the eight articles in this issue resulting therefrom. Many other phases of our specialty could have been selected or added, no doubt, but limitations of space and readily available material were the deciding factors. It is hoped that the articles herewith presented will indicate that orthopedic surgery has advanced markedly from the "strap-and-buckle" days and is related closely to the other phases of medicine.

The Editors are grateful to the authors who developed the information to follow and thank them for their cooperation. We also appreciate the opportunity of participating in broadening the concept of this JOURNAL's title by including a specialty which deals very much with chronic conditions including medical as well as surgical features.

ALLEN F. VOSHELL, M.D., AND
J. VERNON LUCK, M.D.
Baltimore, Md., and
Los Angeles, Calif.

HOW CAN THE MODERN ORTHOPEDIC SURGEON HELP THE GENERAL PRACTITIONER IN THE TREATMENT OF CHRONIC DISEASES?

LEO MAYER, M.D.
NEW YORK, N. Y.

(Received for publication Oct. 1, 1959)

TO avoid the danger of a boring encyclopedic type of paper and to make my contribution as practical as possible I am going to ask you, my readers, to listen to an imaginary conversation between an elderly physician with a large rural general practice and his young son, an orthopedic surgeon who, after excellent training, has passed his Board examinations and has settled in a nearby town. The father is eager to get his son's point of view and the son is equally eager to tell his dad the fascinating story of up-to-date orthopedic surgery. Thus it happens that there is a reversal of the Socratic method: the young man assumes the role of the aging Socrates, the elderly father that of the inquiring young student.

FATHER.—You know, Son, I try to keep up with the times. I read my J.A.M.A. every week but so much is happening that I'm beginning to fall behind. I'm glad you're going to be in the neighborhood to help me with your knowledge of orthopedics.

SON.—Dad, it will be great fun to work with you.

FATHER.—Suppose, since my practice includes patients of every age, we start with the children. Of course, I'm not referring to fractures and acute diseases but to chronic conditions.

SON.—The first thing I must tell you is something you unquestionably already have observed: that is the marked diminution in the number of cases of rickets and scurvy.

FATHER.—I should say an emphatic YES. When I began practicing here 50 years ago rickets was a common disease. The farmers' wives didn't know anything about vitamin D. They rarely gave their babies orange juice and they were afraid of exposing them to the sun. Now that has changed. But even now, in the small towns, particularly among the Negroes and Italians, I find an occasional child with severe rachitic bowlegs and knock knees.

SON.—Send such children to me. We can cure such deformities by osteotomies or, if the children are young enough, by an osteoclasis.

FATHER.—What's that?

SON.—Fracturing the bones manually or with a special instrument called an osteoclast. Actually, in my residency I saw only a few such cases because Dr. Hess's pioneer work on the prevention of rickets has had such widespread

recognition that the disease is a rarity. Milder cases of rickets can frequently be treated by means of corrective braces or plaster of Paris corrective splints. It is, of course, obvious that the diet must be carefully controlled. And as for scurvy, I saw only one case among the thousands of children admitted to the hospital. That child's legs were so sensitive that if you came near his bed he began to cry. His bleeding gums and the characteristic subperiosteal hemorrhages made the diagnosis easy. And the cure was rapid with plenty of vitamin C.

FATHER.—What do you do with congenital hip dislocations?

SON.—There, Dad, you have a great chance to help your patients. Teach the mothers to diaper the babies with the legs held wide apart with an extra diaper. The diaper should be carefully folded so that it will be thick enough to hold the legs in wide abduction, corresponding to what is frequently called the frog position. The late Dr. Putti of Bologna was able to reduce the incidence of dislocations in northern Italy very markedly by this simple technique. If, however, you suspect a dislocation be sure to get an x-ray film of the pelvis. There's a lot of talk nowadays about the danger of x-ray, but if you cover the baby's genitals with a strip of lead the danger is minimal, and there's a great advantage in early diagnosis. Frequently a complete dislocation can be prevented by the early use of the rubber pillow splint devised by Frejka of Czechoslovakia, or by a light metal abduction splint such as the one used by Leffman of Haifa, Israel. If the acetabulum is shallow and the roof shows an abnormal slant use the splint even if the head is not dislocated. Many dislocations are not diagnosed until the children begin to walk. Those you had better send to me, because great care must be used in reducing the dislocation. It has been shown that the blood vessels to the femoral head can be ruptured easily and therefore rough treatment is likely to result in deformity of the head due to aseptic necrosis. These babies are best treated by gentle traction, using the method devised by Hoke of Atlanta, to pull the head down to the acetabulum. Then usually it can be slipped into the socket without any anesthetic and with minimal danger of trauma.

FATHER.—How about clubfeet? I still see quite a few.

SON.—Please send those to me as soon as you can, for treatment should be started early. Most of these are amenable to correction by plaster of Paris and braces such as the Denis-Browne. But occasionally a tight Achilles tendon must be divided, and in severe cases of equinus the ankle capsule must be cut posteriorly. To reduce the equinus position of the os calcis Mayer has advised inserting a Kirschner wire into the os calcis which can be incorporated into the plaster of Paris dressing. Clubfeet are very prone to recur and treatment must often be carried out for a number of years until the orthopedic surgeon is sure of permanent correction. Sir Robert Jones used to apply a critical test, i.e., the ability of the patient actively to evert the foot by means of the peroneal muscles. Even this test, however, is not always conclusive. It is advisable to continue the use of special shoes and night braces even after the foot has assumed approximately normal form.

FATHER.—Son, has any progress been made in solving the mystery of how these deformities occur?

SON.—The most significant work has been done by a Hindu, Dr. Duraiswami.

While in Liverpool with Bryan McFarland and also in Baltimore with Bob Johnson he demonstrated the amazing effects of injecting insulin and other substances into the chick embryo. He was able to produce clubfeet, hip and spinal deformities. Of course, that does not mean that we know how to prevent these deformities.

FATHER.—I know, too, that when one of my patients develops German measles during her pregnancy her baby is likely to be born deaf or blind. I don't suppose you "orthopods" can do much about that.

SON.—No, we cannot. But we are supporting the National Foundation and also the Association for the Aid of Crippled Children in their far-reaching studies into the cause of congenital abnormalities. There is one little deformity in infants which you may see, since it is rather frequent: a flexion contracture of the thumb. We had at least 10 such cases in the hospital during my 3 years. They are caused by a constriction of the sheath of the flexor longus pollicis; I hope you remember enough of your anatomy, Dad, to locate that tendon. The head of our orthopedic department taught me how to cure them: just divide the tight portion of the sheath. Naturally, you must be careful not to cut the sensory nerves of the thumb which run close to the sheath. One of our cases was bilateral. Was that mother happy when she saw her baby using its thumb normally!

FATHER.—That's all very well, Son, to talk of curing a thumb. But what are you doing about serious troubles of the hip and the spine?

SON.—Now you're opening such a big field that I could talk for hours. First, let me congratulate you general practitioners for reducing one of the main causes of severe hip and spinal disease—tuberculosis. My "attendings" told me that when they were students the orthopedic beds were filled with long-standing cases of tuberculosis of the hips and spine. At the old Ruptured and Crippled Hospital in New York 90 per cent of the children's ward was occupied by these pathetic youngsters. Many of them died; those who lived developed severe deformities. The first big step forward came in 1911 when Hibbs and Albee published their methods of fusing the spine. Fusions of the hip were also performed successfully. Rollier in Leysin made a great contribution by demonstrating the curative effect of heliotherapy in high altitudes; at Berck-Plage in France, Calot and Calvé did the same at sea level. But more important has been the comparatively recent chemotherapeutic attack, first by streptomycin, then by isoniazid and iproniazid. Dr. David Bosworth at the Sea View Hospital in New York has demonstrated the amazing effects of these drugs in a large series of desperately sick patients. His success has revolutionized the method of treatment. It is now seldom necessary to fuse either the hip or the spine. Instead, we can attack the focus, excise the diseased bone, implant the appropriate chemical, and expect the wounds to heal per primam. DeRoy and Fisher of Pittsburgh have published papers on a convincing series of spinal cases. In Israel, where there is much tuberculosis among the impoverished immigrants, Dr. Seidenmann has had similar results. So, if you see a case of bone tuberculosis send me the patient. I'm not yet able to match Dave Bosworth, but he has taught me enough to help your patient.

There's a much larger group of patients who will consult you, Dad, because

of a hip limp, not due to tuberculosis. Those in the younger age group, 6 to 10 years, are usually suffering from Calvé-Perthes disease; in the older group, 11 to 14, from slipping of the femoral epiphysis. Both require expert orthopedic attention. In Calvé-Perthes disease there is an aseptic necrosis of the femoral head and the metaphysis. Why it occurs we do not know, but we do know that during the cycle of the disease, which lasts about 3 years, the softened bone must be protected from weightbearing. Operations have been tried, but without much effect. In slipped epiphysis, on the other hand, operation is of the greatest value. This consists in fixing the head to the neck either by an appropriate nail, by long screws, or by a bone graft. The results are brilliant. The patients are cured and may soon resume normal activity. Delay, however, invites disaster; the head may slip so far as to cause a serious deformity. So don't wait; better send the patient by ambulance, if he lives at a distance.

ol. 13
1961

FATHER.—Thanks, Son. I'll try to remember your warning. Tell me now a little about scoliosis.

SON.—That's another big topic. The subject is still controversial, but great advances have been made. One of my teachers, who worked in Germany before World War I, told me a little story to illustrate the defeatist attitude of that time—and remember that Germany was then in the forefront of orthopedic development. He asked a noted German orthopedic professor how long he would treat a case of scoliosis. The answer was, "Till the bill amounts to 500 marks." Now the defeatist spirit has been replaced by one of hopeful confidence. The pioneer work of Russell Hibbs, continued by his pupil, J. C. Risser, by John Cobb, J. H. Moe, and others who relied on spinal fusion, and the conservative efforts of the Milwaukee school, headed by Walter Blount, have enabled us to straighten many a crooked back. The way is long, arduous, and expensive, but the results are encouraging. I hope Dad, that you will educate your patients to watch the backs of their children and send them to me before the curve has become fixed.

FATHER.—We've been so busy talking about bones that we haven't said a word thus far about paralyses. I'm glad to tell you that in these last years, since I've been injecting the Salk vaccine, I have seen only 2 new cases of polio, and both were mild. There are, however, still a number of my patients suffering from paralytic deformities. What should I do with them?

SON.—Send them to me. The surgical correction of such deformities is one of the most fascinating fields of orthopedic surgery. By means of tendon transplants, joint fusions, and other plastic procedures we can improve almost every case. I want to tell you about one of my fellow residents who developed polio as a sequence of volunteering to fight an epidemic in North Carolina. His right arm became useless because of a paralysis of the elbow and shoulder muscles. One of our "attendings" did a Steindler tendon transplant at the elbow and a fusion of the shoulder. The result was a strong arm with which the young doctor was able to resume operating, apply plaster dressings, swim, and play tennis. Another case made a deep impression on me because of the dramatic cure of a pelvic obliquity which caused a discrepancy in leg length of 4 inches. The patient, a young woman, was able to discard her brace and high shoe and her limp almost

disappeared. Other patients do not require operations, but need braces and instruction in how to use them. Our aim with each one is to make him independent and a useful member of his community.

FATHER.—I'm really more troubled by my children with cerebral palsy. Can you say a hopeful word about them?

SON.—Yes and no, Dad. Dr. Winthrop Phelps of Baltimore has studied the disease intensively and has divided it into different groups. Besides the usual spastic type, there are cases showing athetosis, ataxia, rigidities, and congenital tremor. About one-third of the patients have some degree of mental impairment. Naturally, it is the mentally normal with mild spasticity who have the best prognosis. Dr. Phelps insists on the value of nonoperative treatment, but from what I've seen he is losing out to such men as Eggers of Galveston, Texas, Bill Cooper of New York, and Carroll Silver of Providence, who have demonstrated the dramatic results of various operations such as tendon lengthening, divisions of tight structures, arthrodeses, and other plastic procedures. A new society has been formed for the special study of cerebral palsy; yearly meetings are held, and hundreds of patients are receiving constructive treatment. If you have any cases of spastic equinus, knee contractures, or scissors gait, send them to me; I'm sure I've learnt enough to help them. Even the difficult hand cases can be improved.

FATHER.—That sounds encouraging. In fact, Son, you have told me so many ways in which an orthopedic surgeon can help my pediatric cases that even if our talk were to stop right here and now, I'd feel grateful to you. But I hope we can go ahead talking for I want to learn about my adult cases.

SON.—Of course I want to go ahead, for orthopedic surgery no longer confines itself to children as it did at its beginning. You know that André, the father of our specialty, coined the word *orthopaedia* from two Greek words *pais* (a child) and *orthos*, meaning straight, and until the beginning of the twentieth century the orthopedic surgeon did little more than try to make the child straight. Virgil Gibney was, I think, the first to introduce an orthopedic ward for adults into an American hospital, the old Hospital for Ruptured and Crippled in New York. Now that the orthopedic surgeon has taken over the treatment of fractures and other traumas of the extremities, his practice has become more and more devoted to adults. But that is a phase of our work which needs no elaboration. You, as an old-time practitioner, know very well which accident cases you can manage and when you have to call for help. I want to discuss the patients with chronic disease who probably represent the largest percentage of your practice. Actually, the orthopedic surgeon cannot contribute much to the treatment of the patients with cardiovascular disease who fill your waiting room. But I want to call your attention to the statement recently issued by the National Health Committee prepared by eight eminent physicians regarding the factors which predispose an individual to arteriosclerosis, heart attack, and stroke. One of the five factors was overweight. We orthopedists are greatly interested in suitable exercises to help reduce obesity. Maybe you think that exercises would be injurious to the arteriosclerotic individual, but then you would be at variance with these doctors, five of whom were past presidents of the American Heart Association, who held

that moderate physical activity tended to lessen the hazards of arteriosclerosis. If a cerebral accident occurs and the patient survives, the resultant hemiplegia can be made amenable to orthopedic treatment. Exercises and massage are indicated; braces may be used to support the paralyzed leg; even better, the short Achilles tendon may be lengthened and the overactive tibialis anticus tendon which draws the foot into inversion can be shifted to the outer border of the foot so as to convert its action into eversion. At the Institute of Physical Medicine and Rehabilitation in New York many of these cases have been treated with a fair degree of success.

FATHER.—You've given me some new ideas about an old disease. I can think right away of a couple of old hemiplegic patients who would probably be excellent candidates for the operation you suggest. Can you lengthen the Achilles tendon and transfer the tibialis anticus at one sitting?

SON.—Oh, yes. Very easily. The leg is immobilized in plaster of Paris for about a month, but the patients may be allowed out of bed 2 weeks after the operation. Exercises are begun immediately after removal of the plaster.

Vol. 13
1961

Now I want to discuss with you a group of patients who I know have been very worrisome to you—those with chronic or recurrent backache. They are also difficult cases for the trained orthopedist and controversy rages high among experienced men whether the treatment should be conservative or operative. In general nowadays the cases fall into two groups: first, those with definite symptoms of degeneration of the intervertebral disc usually accompanied by leg pain caused by pressure of the extruded disc against a lumbar nerve; second, those without discal symptoms. In the first group, if symptoms do not subside promptly after traction has been applied, a myelogram should be performed. This test, once considered painful and dangerous, can now be considered innocuous if done by an experienced surgeon. It is valuable both in confirmation of the diagnosis of herniated disc and in deciding the level of the involved disc or discs. Remember, Dad, that frequently several discs are involved. If a herniation has been proved the removal of the disc is indicated. Whether this should be accompanied by a fusion of the adjacent vertebrae is another moot subject. In the hospital, where I had my residency, half the attending surgeons believed in a combination of fusion with disc removal; the other half reserved fusion for the occasional case. Both groups seemed satisfied with their results. I, myself, have not as yet had sufficient experience to reach a final decision but I find that my patients are getting along well without fusion and I can get them out of bed 10 days after the laminectomy and disc removal.

The other group of cases, those without disc symptoms, require analysis to decide whether the symptoms are due to postural defects, arthritis, repeated traumatic, visceral, or anatomic abnormalities, neoplasms, or psychoneurotic manifestations. The treatment, of course, varies with the etiology. You, as a general practitioner, can usually spot the patient with a fixed retroverted uterus as the cause of backache. Since you take x-ray films you will also recognize at once the occasional case of spondylolisthesis. Incidentally, not all of these require fusion; some do very well with a good corset. Once in a blue moon you may see a spinal neoplasm. At our hospital we had 3 cases of osteoid osteoma causing

backache. They are difficult to diagnose in the roentgenogram and also difficult to operate upon successfully, but if the osteoma is removed the pain will disappear as if by magic. You can readily see, Dad, what a fascinating field this is for diagnosis and treatment.

FATHER.—Having had quite a little backache myself I am fully aware of the difficulties you mention, but I am not as fascinated by the problem as you seem to be. If my back gets to be too bad you can expect a visit from me, but I do not want a fusion.

SON.—Don't worry. Fusion used to be very popular but I haven't performed a fusion for backache during the past 5 years. In treating backs conservatively I try to determine the cause of the back pain. This is frequently postural or due to arthritis, the kind of work, the bed, or some other detail in the life of the patient. I use appropriate braces, exercises, and chemotherapy, including local injections of hydrocortisone in pinpoint areas of sensitivity. Frequently I have to put patients in the hospital for a preliminary period of traction or of simple bed rest. Very few branches of my work require as much ingenuity as the nonoperative treatment of painful backs, but, with persistence most cases can be helped.

FATHER.—While you're on the subject of backs, tell me about the neck. I guess you consider that part of the back.

SON.—Of course, but the symptoms are usually localized to the cervical spine and the cervical plexus. As in the lumbar spine there may be a herniation of the intervertebral disc. In most cases my experience has been that symptoms are promptly relieved by traction and the subsequent use of a well-fitted cervical support or collar. Many of the chronic cases are caused by trauma, many others by arthritic changes. Some of the most progressive surgeons favor early exploration and removal of the offending disc; the surgical approach may be anterolateral as well as posterior. I have been much pleased by the results of injection of hydrocortisone if the lesion can be sharply localized. I remember one noted cellist who came to me because of numbness and paresthesia of the right thumb. The disturbance of sensation was so marked that he had great difficulty in controlling his bow. Fortunately, a single injection of hydrocortisone relieved the condition completely.

FATHER.—I had no idea hydrocortisone could be used for that purpose. I have tried it for painful shoulders, but I'm afraid my technique is not too good.

SON.—Possibly that's true, but I'm sure I could teach you. Most painful shoulders are the result of microscopic tears of the supraspinatus tendon, frequently with subsequent tendonitis and deposition of calcium. If a calcium deposit is visible in the x-ray, try to hit the deposit with the needle. Inject first 3 or 4 c.c. of procaine solution or a similar local anesthetic, then 1 c.c. of hydrocortisone solution. Often this is followed by a painful reaction lasting a few hours, but then the pain and muscle spasm begin to subside. If no calcium deposit is visible aim the needle at the most sensitive point and inject close to the humerus. Usually 4 or 5 injections are sufficient to cure. Occasionally there will be a resistant case which will require open operation for removal of a calcium deposit. Of course there are other cases due to involvement of the long head of the biceps.

FATHER.—Do you realize, Son, that we've been chatting for over an hour

and I haven't yet heard a word from you about a large group of my patients—those with chronic arthritis. I wonder whether you realize how many there are in my practice and how troublesome they can be both to themselves and to me.

SON.—I was coming to them next. Of course, Dad, you know more about their medical treatment than I do. I'm sure that you have had some fine results with the corticosteroids and that you've also seen some of the disturbing side effects. I usually call in a specialist in rheumatology to help me since the field has become so complicated and there are such a confusing number of new drugs. I confine my orthopedic work to surgery in the selected cases. The arthritic knee and hip can often be helped by operation. In the knee the main source of pain may be a torn meniscus or an inflamed retropatellar fat pad. If the degeneration of the synovial membrane is very extensive, a synovectomy may be done, and in the more severe cases with marked ulceration of the joint cartilage, a fusion. Some men have had good results with arthroplasty, notably Dr. Kuhns of Boston who uses nylon as interposition material; but my attempts have not been encouraging. The patients who have suffered for years are particularly grateful to the surgeon after a successful fusion.

At the hip the problem is similar. If the process is confined to one hip, fusion is, I think, the best operation. If, however, both hips are involved the question is not easily answered. Mr. Alexander Law in London, Dr. Aufranc in Boston, and Dr. Larsen in Iowa City have demonstrated remarkably good results with the Smith-Petersen Vitallium cup, but few others have been able to achieve the same degree of exquisite technique which they possess. The insertion of prosthetic appliances, either of metal or plastic material, though hailed at first as the perfect solution, has not given many permanent cures. The Milch operation, which consists of resection of the head and angulational osteotomy, gives relief from pain but leaves the patient with a limp. The same holds for the method of Scaglietti who simply resects the enlarged femoral head. Consequently, it seems to me that we must try to learn how to do the Smith-Petersen operation since it gives the best results in the bilateral cases.

Before we stop this long talk I must tell you about my experience with a few cases of gouty tophi located in the hand and foot. Some of these had ulcerated through the skin, were infected, and were causing much pain. In some the underlying bone was involved. I treated these with excision of the tophi, curettage of the involved bone, packing, and local antibiotics. All of them healed remarkably well.

FATHER.—Son, you have taught me a lot. I am sure many of my patients will be glad you became an orthopedic surgeon.

DISABLING FRACTURES IN THE AGED

EDGAR M. BICK, M.D., F.A.C.S.*
NEW YORK, N. Y.

(Received for publication Nov. 1, 1959)

ANY discussion concerning the chronically disabled may no longer include only the admittedly major problems of disease. With the rapid increase of mechanization in modern civilization and its necessarily parallel growth of rapid transportation, cases of chronic traumatic disability have grown to such proportions as to greatly modify many social and economic problems in community care. To recognize the effect of these changes one should speak not of the problem of chronic disease but of the broader concept of *chronic disability*. This latter term would include the medically incapacitated as well as the traumatically disabled. Problems of public health and prevention, as well as care and maintenance, present a single charge to community welfare and a comparable challenge to medical progress. Just as certain chronic diseases of the elderly often can be mitigated, if not prevented, so can posttraumatic disability be lessened, if not substantially eliminated, by a proper understanding of the effect of trauma in the aged person and his potential response to various methods of treatment and aftercare.[8,10,26]

Various surveys of the older age groups employed in industry have disclosed two observations pertinent to this subject.[12] The first is the fact that the older worker suffers from no significantly higher accident rate than do his younger co-workers. However, when the older worker is injured he suffers a considerably higher rate of fatality and disability.

It is axiomatic that any trauma causes some degree of partial permanent disability. It has become a matter of common experience that the degree and persistence of disability in the aged victim depend upon more than the physical damage done to a part of his anatomy. It may be equally influenced by the effect of the trauma on his more general physiologic processes, and very importantly, his emotional reaction.[19] Among the aged both of these latter factors may be very real and may not with impunity be ignored or belittled. The aged often have neither the physical nor the spiritual resiliency to overcome these secondary effects, nor is it as feasible to correct them by medical or psychiatric therapy as it might be in a younger group.

Besides these corollary effects of the incident of trauma there must be considered the high probability of pre-existing disease or tissue degeneration being worsened by the experience, or at least complicating the process of recovery.[6,28,33,34]

*Attending Orthopedic Surgeon, The Mt. Sinai Hospital.

The relationship between the two is quite variable and at times, especially in the matters of legal responsibility, justifiably controversial. When an individual whose severely fractured tibia has healed satisfactorily is unable to resume his customary ability to walk about 6 months or a year postfracture, because of ischemic claudication based on a preceding progressive arteriosclerosis, it is extremely difficult to determine to what extent his disability is the result of trauma, or to what extent it is due to the natural progress of his obliterative vascular lesion during that period.

However, even allowing for the generality of modifications in the response of the aged body to trauma, it is more pertinent to this essay to limit the subject to those specific effects of fracture which in themselves commonly lead to a greater or lesser degree of permanent disability regardless of the superimposed factors of disease, tissue degeneration, or the psychic instability of senility. Indeed, the excuse for this essay lies in the fact that properly planned management of such cases may often mitigate the degree of ultimate dysfunction to the point at which, within reasonable limits, the victim need not become significantly disabled.

ol. 13
961

FRACTURES OF THE VERTEBRAE

Fractures of the vertebrae must be considered in two categories which, from the point of view of treatment, are completely diverse subjects. Those fractures which involve the spinal cord are always a matter of serious concern at any age. In the elderly they are very apt to be fatal, or if not, seldom susceptible to significant rehabilitation. Simple compression fractures without cord involvement respond very well to proper management, even in advanced age, if certain principles are followed.[5,30]

The period of bed rest is determined solely by the duration of acute immobilizing pain. As soon as possible the patient begins to get out of bed at intervals and to sit loosely in a chair with motions of the limbs encouraged. *It is most important to keep in mind that in the aged a great deal of the persistent after-pain of compression fractures of the veretebrae is due to the strains placed upon the associated spinal ligaments and often is found (unlike the tenderness) at some distance from the fracture.* Therefore a light corset support is useful to relieve these strains during the recovery stage.

After the fifth or sixth week (occasionally longer) properly guarded lightweight exercises have proved valuable in overcoming residual symptoms. Such exercises have been devised for the aged by Mrs. Effie Gulatsi, C.T., and will be published separately. The principle involved is that the exercises are mainly directed by means of limb movements and spinal muscle contractions. The direct strains of back or trunk lifts against gravity are avoided, since the relatively inelastic paravertebral ligaments are more often than not strained by the movements customarily used in the rehabilitation of younger adults.[9]

There is, of course, a third category of fractures of the vertebrae of particular interest in dealing with the aged, but it needs only to be called to mind and requires no special discussion. The osteoporotic spine of the elderly person is frequently subject to compressions which appear to be no different than those caused by

trauma but which may be quite asymptomatic.[17] These require no treatment in themselves and must not be overstressed when found in a patient presenting himself with generalized backache of some duration. The mere mention of the word fracture under such circumstance by the surgeon is enough to provoke an iatrogenic disability out of what might otherwise be the occasional complaint of an aching back.

FRACTURES OF THE HIP

Fracture of the femoral neck in the aged leads inevitably to permanent disability. The degree of disability varies and at times may be altered by treatment. Several follow-up studies of large series of cases indicate that in the best run clinics approximately 75 to 85 per cent of fractures of the hip with displacement, treated under favorable circumstances, will unite.

In all cases that do not unite, and in 25 to about 35 per cent of cases in which union occurs, the femoral head will still be deformed in less than 2 years by subsequent avascular necrosis. The later development of osteoarthritic deterioration, or its aggravation when present before fracture, has never been statistically estimated but it is all but inevitable. The extent to which avascular necrosis or osteoarthrosis disables the individual is a highly variable factor, and it is common experience among those who have studied the subject that the degree of pathologic change visible on x-ray film is not necessarily indicative of the subjective or objective disability suffered by the victim. Especially in the aged, where the activity of life has already been restrained, not too much is demanded of the hip joint and the patient may reasonably well accommodate himself to a degree of postfracture deformity at the hip which in an active younger adult would prove intolerable.

Treatment of fracture of the hip in the aged is a subject which far transcends the limits of this essay. A few remarks may be pertinent. In brief, the primary object of treatment in the aged is to avoid the necessity of prolonged bed rest; that is to save life. Time and again it has been demonstrated that the mortality rate of any method of treatment of this fracture which confines the elderly patient to bed far outruns the mortality rate of surgical intervention. However, when internal fixation by nail or pin is too great an immediate risk, and this decision must be based on specific medical circumstances, never merely on the decrepitude of age, Astley Cooper's method of 1822 is still valid.[3,14] Cooper's method merely recognized the inadequacy of treatment in his day, but appreciated the high mortality rate of neglect. The patient was put to bed for a few days to a week, with the fractured hip resting on pillows. No other restraint was permitted. At the end of that short period he was placed loosely in a chair and urged to move his limbs. As soon as tolerable he was given two canes and encouraged to get about. This method can and has still been used. The patient is of course permanently disabled. But to some extent so would any old patient whose medical condition was so precarious as to contraindicate hip nailing. Actually with a heel lift on the shortened extremity, and the use of three-point walking sticks, it may amaze one how relatively well the patient does move about.

The opportunity of using artificial endoprosthesis either as a primary

procedure or a salvage procedure in fractures of the hip was popularized by the reports and improved apparatus appearing with increasing optimism since the publications of Judet and his early followers in the 1940's.[18,22,24,29] It has been proposed as a primary procedure chiefly in the high subcapital fractures of the aged. It has been offered as a salvage procedure in all ununited fractures of the hip and those spoiled by postfracture avascular necrosis. The subject is at present quite controversial and in any given case the decision must rest upon the judgment and experience of the responsible surgeon.[23] It must again be emphasized that fracture of the hip in the aged is always permanently disabling to some degree. Whether the degree will be less following the insertion of an endoprosthesis or by the employment of other methods, such as osteotomy with early ambulation, cannot at this time be decided by the evidence of statistical probabilities.*

ol. 13
1961

FRACTURES OF THE FEMUR

Shaft and Lower End.—These fractures appeared in about 2½ per cent of the six hundred cases of fracture of the aged previously reported.[8,10] It is fortunate that they occur no more frequently among the elderly since they are accompanied by a very considerable degree of disability. One might glibly pass off a discussion of treatment of the femoral shaft by the mere mention of the currently fashionable intramedullary nailing. However, in the aged, the problem is not quite so facile. If one is dealing with a well preserved relatively "young old person," whose tissues are reasonably firm and virile there is no question but that intramedullary nailing is indicated, and that fairly early ambulation with crutches will ensue.

On the other side of the picture are the complicating factors which often accompany physiologic old age. In the presence of advanced osteoporosis the femur will certainly admit the intramedullary nail, but attempts at early ambulation may cause the nail to cut through the soft cortex, to shift up or down into the end areas, if not through the articular surfaces, or to increase the local areas of bone atrophy to the point where weight bearing would jeopardize the immobilization of the healing site. In brief, intramedullary nailing of an osteoporotic femoral shaft might introduce physical and histologic elements which could retard union rather than hasten it.

Nevertheless, since the only alternative to intramedullary nailing in such cases is traction, ambulation would be equally prevented for the same period of time. The lesser evil therefore appears to be intramedullary nailing of the fractured femoral shaft in the aged. When performed, the patient is of course permitted out of bed in a chair at the earliest feasible moment, determined entirely by the postoperative recovery.

However, there are times when open surgery cannot be permitted because of specific medical prohibitions. (In reference to this let it be always remembered that intramedullary nailing of the femur is far from "minor surgery" and never the completely innocuous procedure it is too often presented to be.) In such instances, Russell traction with the stirrup attached to a Steinmann pin placed

*(Comment by the editors: orthopedic surgeons generally stress the importance and value of prompt fixation of acute fractures, hoping to avoid some, at least, of the features described by this author, providing the patient can tolerate the procedure.)

through the lower end of the tibia under local anesthesia is a far more comfortable apparatus among the aged than is the balanced suspension traction system which is admittedly more efficient in the younger adult. The Steinmann pin placed just above the malleoli is easily tolerated and eliminates the serious inconvenience of adhesive or other skin traction applications. With the pin, concern about the circulation in the leg is to a great extent avoided. Russell traction allows very free motion in bed and when the elderly patient is properly supervised with daily exercises performed in bed physical regression need not take place. Unfortunately the traction method does demand a minimum of 10 weeks for safe union, but it must be emphasized that the method is used only in those cases in which marked debility or other medical factors make intramedullary nailing not feasible, or at least an unwarranted risk.

Fractures about the lower end of the femur may be far more disabling to the elderly skeletal system than are those of the shaft. There are two classic types: (1) impacted fractures of the condylar end into the shaft, usually with some comminution involving the articular surface but with little angular displacement, and (2) fractures in which the condylar area is angulated forward or backward on the shaft. The first type is best treated in the elderly patient with light-rein immobilization and little attempt at "painting the lily," i.e., remodelling the condyles. With marked displacement a pin may be used to hold the separated condyles together. Aside from this a simple brace, a knee-cage without hinged joints, or a light plaster is sufficient to maintain position. The fragments do not slip away and nonweight-bearing crutch walking is permitted as soon as the patient's strength will permit.

This is a damaging fracture at any age and inevitably leaves some degree of permanent restriction at the knee joint. The use of a bladeplate in such fractures in the aged adds nothing to the speed or degree of recovery, and may even lessen the extent of recovery of knee motion at a later date.

In the second class of fractures at the lower end of the femur, those with marked anterior or posterior angulation, surgical reduction is as necessary in the aged as in the younger adult. True reduction may be effected by the two-pin balanced suspension first devised by Watson-Jones during World War II,[31] but this entails unnecessary confinement in bed, a situation which in these fractures, unlike those of the shaft, may be avoided with relative safety by surgical intervention. Through a lateral incision the lower fragment is brought into line and held by the right-angled bladeplate customarily employed in such cases. In the aged patient the decreased strength of the muscle pull against the plate lessens the disadvantage of the relative softness of the atrophic bone. The leverage at the lower end of the femur is far less than that in the shaft partly because the fracture surface is of much larger diameter. Again early ambulation without weight bearing on the fractured side is encouraged in walkers or crutches.

In each of these lower end femoral fractures some degree of restraint of knee motion is inevitable. The degree of motion recovered depends to a great extent on the choice of method, the aptness of its use, and the cooperation of the patient during the period of aftercare. However, good recovery in shaft or lower end fractures of the femur in the aged should not be impeded by futile surgical

attempts to restore normal contours at the expense of fibrosis and scarification of periarticular soft tissues, or the further destruction of osteoporotic or atrophic bone.

FRACTURES OF THE TIBIA

It is too often forgotten that nonunion occurs in fractures of the tibia more often than in any other bone of the skeleton. It has not been the present writer's observation that modern methods of internal fixation have materially changed this fact. Nonunion of the tibia in the aged is catastrophic. They simply do not have the time for the long disability which inevitably follows failures in surgical attempts to assist union. It has been a widely held impression that although internal fixation may permit earlier ambulation it has not hastened the process of reparative osteogenesis.[2] In fact some observers feel that it may retard it.[31] Most fractures of the tibia will heal directly if the extremity is held in plaster. In a well applied plaster cast the elderly patient may be easily placed in a wheel chair and permitted considerable activity therein. If the patient is sufficiently agile walking with crutches may be allowed without weight bearing in 2 or 3 weeks.

The real objection to the plaster treatment of fractures of the tibia, in younger adults, with or without fibula, is the fear of "slipping" of the fragments in oblique fractures, with subsequent shortening, or of angulation in transverse fractures. In properly controlled plaster techniques, slipping should not exceed half an inch. Angulation may show a cosmetically unpleasant protuberance of the leg, but little more. Neither of these is as much a threat to the elderly patient as is the threat of nonunion, infection, or repeated operation which too often accompanies the surgical measures advocated for such fractures. A quarter or half inch lift on the heel will compensate for the former, and trousers or skirt will conceal the latter.

Fractures of the tibial condyles in the aged do not ordinarily represent the same degree of disability as in the younger adult. Only the very severely displaced or markedly depressed instances require surgical correction. It has been shown that the knee will accommodate itself to a moderate discrepancy in articular surfaces, and an apparent early laxity of the joint will tighten during the course of the year.

Plaster or knee-cage immobilization with nonweight-bearing crutch walking for 7 to 8 weeks, with daily knee motion after the second or fourth week will usually suffice. By the eighth week cane walking may be permitted, if tolerable. Gravity exercises continue until flexion has reached 90 degrees.

Severe disability in the sense in which it is used here does not ordinarily follow fractures of the ankle in the aged person. There is inevitably some persistence of pain in the joint on weight bearing but with reasonable accuracy in reduction, relative to the demands made in the daily life of the elderly, the patient should be able to resume his ordinary activities after the fracture is healed. Most of such fractures require the same period of plaster immobilization as is required in the treatment of the younger adult. This may be 6 to 10 weeks, depending upon the nature of the lesion.

Simple fractures of the malleoli *below the line of the ankle joint* do not involve weight-bearing lines and may be treated with adhesive strapping or leather anklet. Ambulation with a cane may be permitted as soon as it is tolerable.

FRACTURES OF THE FOOT

Fractures of the tarsus, metatarsus, or phalanges are treated in the elderly as in younger people and do not ordinarily lead to significant disability beyond moderate discomfort in sustained weight bearing.

FRACTURES OF THE UPPER EXTREMITY

Uncomplicated fractures of the upper extremities in the aged need not lead to severe degrees of permanent disability though they are very apt to cause mild to moderate chronic pain and measurable limitations of function. However, certain complications of such fractures occur perhaps more frequently in the aged than in younger adults and when they do they may be disastrous. Damage to the neurovascular bundle in and just distal to the axilla in fractures about the shoulder, lesions of the brachial artery at or below the antecubital fossa leading to severe ischemic necrosis, injury to the major nerves about the elbow, stiffness of the hand and fingers in hand fractures, severe prolonged carpal osteoporosis, and carpal tunnel syndrome following fractures about the wrist are among these complications. Some of the concurrent lesions and syndromes are caused by the trauma itself either at the time of injury or as an inevitable result of it. Others are, to at least some degree, avoidable by choice of treatment and meticulous aftercare.

Treatment of fractures of the upper extremity in the aged is for the most part not different from that urged in younger adults. Those at the upper end of the humerus are among the most common fractures of the aged, standing fourth in frequency (about 10 per cent). Treatment is by swathe and sling or sling alone for 2 or 3 weeks followed by freedom of use and encouraged purposeful activity. At the elbow choice of treatment is not different from that used in younger adults although perhaps surgical indications are fewer. The use of intramedullary nailing in the radius and ulna is objected to on precisely the same grounds as is its use in the tibia.

Fractures of the wrist require careful reduction if markedly displaced and it is best done under light thiopental sodium anesthesia. Reduction under local anesthesia should be performed only by experienced hands. If the fresh fracture hematoma cannot be infused by the anesthesic, reduction should not be attempted. Periosseous infiltration does not give proper anesthesia and is remarkedly conducive to postfracture painful osteodystrophy. Undisplaced fractures of the wrist are suitably held by a light splint rather than plaster cast.

Fractures of the metacarpals are chiefly of cosmetic interest in the elderly. The lightest splint, removed at the earliest possible time, will preserve more function in the hand than any attempt to restore contours of the metacarpals or digits at the expense of firmer or more prolonged splinting. There is no admissible

excuse for introducing wires or nails into the already fibrotic hands of an elderly patient.

Although uncomplicated fractures of the upper extremity may lead to prolonged or even permanent discomfort and limitation of local function, they do not present the same degree of bodily disability as do fractures of the lower extremity. Hence, except perhaps in certain fractures about the elbow, surgical intervention is seldom justified. The present or impending threat of vascular interference is of course catastrophic and demands the same urgent management that it requires at any age. Nerve damage must be judged on the degree of disability it leaves relative to the patient's age and requirements and its treatment must of necessity rest on the judgment of the responsible surgeon.

ol. 13
1961

REFERENCES

1. Albright, F.: Osteoporosis, Ann. Int. Med. **27**:861, 1947.
2. Bick, E. M.: Structural Patterns of Callus in Fractures of the Long Bones, J. Bone & Joint Surg. **30A**:141, 1948.
3. Bick, E. M.: Source Book of Orthopaedic Surgery, ed. 2, Baltimore, 1948, Williams & Wilkins Co., p. 298.
4. Bick, E. M., and Copel, J. W.: Senescent Human Vertebra, J. Bone & Joint Surg. **34A**:110, 1952.
5. Bick, E. M.: Management of Fractures of the Vertebrae in the Elderly, Am. J. Surg. **87**:764, 1954.
6. Bick, E. M.: Physiology of the Aging Process in the Musculo-Skeletal Apparatus, Geriatrics **10**:274, 1955.
7. Bick, E. M.: Vertebral Osteophytosis, J. A. M. A. **106**:828, 1956.
8. Bick, E. M.: General Principles of Fracture Management in the Aged, Surg. Gynec. & Obst. **106**:343, 1958.
9. Bick, E. M.: Clinical Aspects of Aging in Human Connective Tissues, Bull. New York Acad. Med. **35**:547, 1959.
10. Bick, E. M.: Trauma in the Aged, New York, 1960, Blakiston–McGraw-Hill Company.
11. Boyd, H. B., and George, I. L.: Fractures of the Hip. Results Following Treatment, J.A.M.A. **137**:1196, 1948.
12. Burns, R. K., and Brown, L. B.: *in* Lansing, A. I., editor: Cowdry's Problems of Aging, ed. 3, Baltimore, 1952, Williams & Wilkins Co.
13. Cleveland, M., and Fielding, J. W.: A Continuing End-Result Study of Intracapsular Fracture of the Neck of the Femur, J. Bone & Joint Surg. **36A**:1020, 1954.
14. Cooper, A.: Fractures and Dislocations of the Joints, London, 1822, Longman Hurst.
15. Cowdry, E. V.: *in* Lansing, A. I., editor: Cowdry's Problems of Aging, ed. 3, Baltimore, 1952, Williams & Wilkins Co.
16. Edwards, W. C.: Fractures in the Hip in Elderly Patients, J.A.M.A. **157**:1635, 1955.
17. Gershon-Cohen, J., Rechtman, A. M., Schraer, H., and Blumberg, N.: Asymptomatic Fractures in Osteoporotic Spines of the Aged, J.A.M.A. **153**:625, 1953.
18. Judet, J., and Judet, R.: The Use of Artificial Femoral Head for Arthroplasty of the Hip Joint, J. Bone & Joint Surg. **32B**:166, 1950.
19. Kennedy, R. H.: Management of Injuries in the Aged, Bull. New York Acad. Med. **32**:487, 1956.
20. Kleinberg, S.: The Value of Early Weight Bearing in the Treatment of Fractures of the Neck of the Femur, J. Bone & Joint Surg. **19**:964, 1937.
21. Levenson, S. M.: Birkhill, F. R., and Waterman, D. F.: The Healing of Soft Tissue Wounds; the Effects of Nutrition, Anaemia and Age, Surgery **28**:905, 1950.
22. Lippmann, R. K.: The Transfixion Hip Prosthesis, J. Bone & Joint Surg. **39A**:759, 1957.
23. Lippmann, R. K.: *in* Bick, E. M.: Trauma in the Aged, New York, 1960, Blakiston–McGraw-Hill Company, Chap. 8.
24. Moore, A. T.: Metal Hip Joint. A New Self-Locking Vitallium Prosthesis, South. M. J. **45**:1015, 1952.
25. Overton, L. M.: Fracture of the Hip in the Aged and Disabled, Clin. Orthop. **11**:51, 1958.
26. Rowe, C. R., and Detwiler, R. C.: Fractures in the Aged, J.A.M.A. **162**:1517, 1956.
27. Shock, N. W., *in* Lansing, A. I., editor: Cowdry's Problems of Aging, ed. 3, Baltimore, 1952, Williams & Wilkins Co.
28. Tannenbaum, C. S.: The Relation of Concomitant Disease to the Occurrence and Management of Trauma, Am. J. Surg. **95**:897, 1958.

29. Thompson, F. R.: Vitallium Intramedullary Hip Prosthesis, New York J. Med. **52**:3011, 1952.
30. Turner, V. C., and Mead, N. C.: Compression Fractures of the Dorsal, and Lumbar Spines in Elderly People, S. Clin. North America **195**:195, 1949.
31. Watson-Jones, R.: Fractures and Joint Injuries, ed. 4, Vol. 2, Baltimore, 1955, Williams & Wilkins Co.
32. Whitman, R.: A New Method of Treatment for Fractures of the Neck of the Femur, Together With Remarks on Coxa Vara, Ann. Surg. **36**:746, 1902,: also J. Bone & Joint. Surg. **12**:11, 1930.
33. Zeidman, F. D.: Accident Hazards of the Old Age, Geriatrics **3**:15, 1948.
34. Zeman, F. D.: Recent Contributions to the Medical Problems of Old Age, New England J. Med. **257**:317, 1957.

Vol.
196

SOME PROBLEMS OF NEUROMUSCULAR DISEASES WITH ADVANCING YEARS

THOMAS GUCKER, III, M.D., F.A.C.S.*

LOS ANGELES, CALIF.

(Received for publication Nov. 1, 1959)

ol. 13
1961

WE ARE now reaping the benefits of modern treatment in reducing the mortality and morbidity of acute infections, certain metabolic diseases, and previously fatal congenital anomalies of the heart and great vessels. Many illnesses need no longer be treated in hospitals and those patients who require hospitalization for acute conditions convalesce more rapidly. The more insidious ravages of chronic affections have a longer life span in which to produce their deleterious effects which therefore become all the more important.

SCOPE OF THE PROBLEM

We will consider the subject of neuromuscular diseases in two temporal frames of reference. First is the duration from the onset of symptoms in reference to a follow-up period. For the analysis of cancer treatment, a suitable yardstick may be a five-year period. For the determination of the effects of poliomyelitis beginning in childhood, a twenty-year follow-up brings us only to the prime of life. Second, chronic neuromuscular disease must be considered in the light of the intervening consequences of aging and the complications induced by intercurrent, usual ills to which the flesh is heir. A lifelong viewpoint is required in the realization that longevity is on the increase even among the crippled.

Several types of neuromuscular diseases are suitable for this discussion because of physical and psychological similarities. Those selected are: paralytic poliomyelitis, spina bifida vera, and spinal cord injuries. Whereas the first is fortunately on the wane, we encounter more patients who present needs as adults than ever before. With the rising world birthrate there are more paraplegics from spina bifida. As horsepower and auto sales increase, traumatic quadriplegia and paraplegia inexorably follow in tragic numbers.

COMMON DENOMINATORS

These three conditions have certain considerations in common which can be discussed categorically. Some of these are bad and others good.

Immobilization.—Immobilization resulting from paralysis or immobilization required during treatment is a concomitant of these afflictions in varying degrees

*Director of Rehabilitation, Orthopaedic Hospital.

and for variable periods of time. Systemically even bed rest can result in considerable loss of nitrogen, potassium, phosphorus, and calcium from the musculoskeletal system.[15] Studies of normal subjects immobilized in plaster casts in bed showed even greater catabolic effects.[4] When muscular paralysis is already present and casting of parts of the body is necessary, this rigid immobilization can result in serious limitation in ranges of joint motion and even in a destructive arthrofibrosis as reported by Luck.[11] Clearly, immobilization must be employed only for the least possible time required and every effort should be made to minimize its harmful effects by conditioning exercises in bed and by the use of rocking beds or tilt tables. Regulated diet and endocrine supplements can then be more effective in counteracting the catabolic effects and osteoporosis.

Obesity.—Aside from the recognized hazards of obesity on the cardiovascular system in every individual, this may become the most incapacitating of all disabilities in the patient with severe paralysis. In part because of enforced inactivity, such patients are prone to gain weight, and after a period of time, weakened muscles are incapable of functioning under the added burden. This is a tragic sequela which should be guarded against from the beginning of treatment. Many a wheelchair patient is so condemned because this aspect of his care was not controlled. Here often the physician must enlist the wholehearted cooperation of the family and wisely arrange for adequate substitutes for emotional eating, when needed. Generally the crux of the problem is dietary rather than endocrine.

Progressively Disabling Deformity.—Particularly in poliomyelitis and spina bifida, the critical period of growth sets the stage for the development of skeletal deformities. Irreversible paralysis of the trunk and lower extremities even when severe does not prevent reasonable efficiency in standing, walking, and gainful employment. But in the face of rigid deformation (Fig. 1), the skeleton cannot be braced to compensate for paralysis and the patient may be chair or bedridden. The tragedy of this consequence is that of progressive limitation of function and greater disability with the passage of years although the paralysis remains stationary. The general practitioner is less likely to realize the great importance of this fact since he may not be able to follow the patient's course for a sufficient length of time. In the early months the problem may be confined to shortened muscles and contracted soft tissues. Without proper treatment as growth continues, the bones must sacrifice their alignment to unequal forces and a distorted skeletal framework results. Whereas permanent paralysis must be accepted at this stage in our knowledge, the crippling secondary changes must not be.

Greater Energy Requirements for Physical Activity.—One must think of the locomotor system as a machine. At best, the efficiency of its operation is threatened by the twentieth century mode of living. Examination of draftees in World War II revealed a shocking incidence of poor physical condition. Think then of an individual with paralysis of both lower extremities and trunk who requires bilateral long leg braces and crutches to walk. Each step demands the overuse of the remaining muscles to work against gravity since inertia is great and the normal mechanism of utilizing momentum is impossible. A study by Gordon[5] of eleven poliomyelitic and traumatic paraplegic individuals revealed that in 4 patients, crutch walking with a swing-through gait on a continuous basis produced

exhaustion comparable to that seen in a normal person performing a 440 yard run.

Simonson and Keys[14] found that in terms of cardiovascular-pulmonary demands the teen-aged paralytic patient with one leg braced requires an energy expenditure of 1.5 to 2.6 times the normal for level walking up to 3 miles per hour. Is this not all the more reason for a periodic medical examination with particular attention to the control of diet, blood pressure, anemia, and metabolic disturbances?

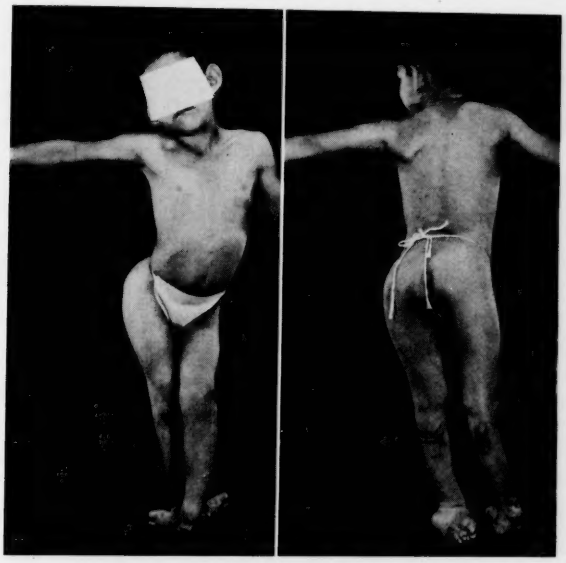


Fig. 1.—Front and back views of six-year-old-boy with spina bifida. With growth, deformities of the feet and flexion contractures of the hips have produced greater disability than the original paralysis. Note the pressure sores on the back of legs.

Social Psychological Repercussions.—This vast subject is now becoming better understood by expansion of testing and follow-up programs and can be touched on only briefly here. As reported by Barker and co-workers[1] certain tendencies have been emphasized. Whereas most public verbalized attitudes toward disabled persons are mildly favorable, deeper unverbalized attitudes are more often hostile. The attitudes of disabled persons and physically normal associates are often conflicting with respect to the meaning of curiosity, sympathy, misfortune, and the giving and receiving of help. The attitude of disabled individuals toward their own disabilities was found to vary widely, have little relation to the degree of disability, and to be related to personality characteristics.

Fortunately one of the more encouraging aspects of polio, spina bifida, and spinal cord injuries is the sparing of the premorbid intelligence. Also studies of teen-age orthopedically handicapped children, by Kammerer,[7] revealed that crippling has no unique influence on the child's behavior, vocational and play interests, and friendships. The desire to grow up showed no clear deviation from

normal. The ultimate adjustment to disability therefore depends heavily upon the parents and teachers in childhood and upon the family and society in adults.

Of great practical importance, however, is the psychological handicap of limited employment potential which remains despite efforts to "Hire the Handicapped." A study made by the California Bureau of Vocational Rehabilitation[2] showed that 290 different occupations were being filled by 3,925 disabled persons, yet it was judged that only approximately 30 per cent of the job operations surveyed could be handled by disabled persons.

Treatment Available.—Another extremely favorable factor in approaching these problems is the great improvement in both the know-how and availability of superior treatment. Improvement in general medical methods is increasing the survival rate of the severely paralyzed patient and maintaining his metabolic equilibrium so that greater benefits are afforded by specific orthopedic techniques. There are more hospitals, clinics, and organizations now in operation to help the handicapped than ever before. Through these sources and their publicity, a more favorable attitude in general is appearing.

The particular examples selected for discussion will serve to emphasize these factors. It is impossible to analyze each one completely but certain points are pertinent.

SPECIFIC DISEASES

Paralytic Poliomyelitis.—This exemplifies a neuromuscular disease predominantly producing a flaccid paralysis of varying degrees allowing for tremendous rehabilitation possibilities. With adequate follow-up so that specific treatment is provided over a period of years, the results bear witness to the total benefits that can accrue. A representative survey by Lowman and Seidenfeld[8-10] in Los Angeles, of 203 male and 234 female subjects included 48 per cent severely disabled, and 75 per cent who had defects readily apparent to others. In regard to social adjustment, 85 per cent of the males and 89 per cent of the females with severe involvement were considered to be within normal limits. The findings concerning employment were almost as favorable. Evidently proper judgment as to placement in industry is essential. Of those who were employed, 77.6 per cent had apparent defects due to paralysis. Of great importance is the advantage that polio patients have no disturbances of bladder and bowel control, no loss of sensation, and appear to suffer less from degenerative arthritis.

Certain sequelae are more serious than others and the most devastating is scoliosis when considered from the standpoint of mortality and morbidity.[13] The obvious skeletal deformity indicates the orthopedic problems involved. Studies in recent years of respiratory function in paralytic scoliotic patients have shed light on physiological handicaps which may be even more important in terms of endurance and work capacity. For example, a man who had poliomyelitis at age 3 developed very severe scoliosis (Figs. 2 and 3) in addition to paralysis of both lower extremities. When studied at the age of 46 he had dyspnea and fatigue after walking two blocks with crutches and braces. Pulmonary function studies indicated significant reduction in vital capacity and compliance of the lungs, and an abnormal distribution of inspired air.[6] In short he is more a respiratory cripple

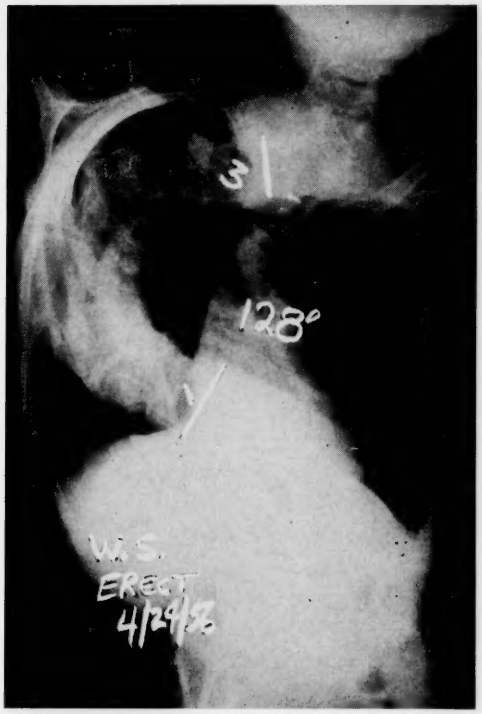


Fig. 2.—Anteroposterior view of severe scoliosis with extreme deformation of ribs resulting in serious impairment of respiratory function at age 46 years.

since other patients without scoliosis but with similar paralysis of the extremities are capable of continuing physical activity and work successfully, well beyond middle age. Subjectively at the age of 25 he was in good health and had good endurance for walking and work. This would have represented a 22-year follow-up at which time the rating would have been good. However, 21 years later the story was quite different, and the wages of aging and the usual respiratory infections had produced a significantly greater disability. The obvious lesson is the great need to provide every possible orthopedic treatment early to prevent or correct the scoliosis in childhood before severe deformity precludes the benefits of treatment and paves the way for the ravages of later life.

Spina Bifida.—In the past few decades the prognosis for life in spina befida has changed from a ten year to a nearly normal expectancy. This depends in great part upon the proper management of the complications of pressure sores because of changes in skin sensation and urinary tract infection from loss of bladder control. By making the family and patient aware of the importance of these factors, the physician initiates the process of rehabilitation by emphasizing the preventive measures which must be practiced throughout life. This attitude is all the more important because the benefits of modern orthopedics can prevent crippling from progressive skeletal deformity, and in certain cases by appropriate

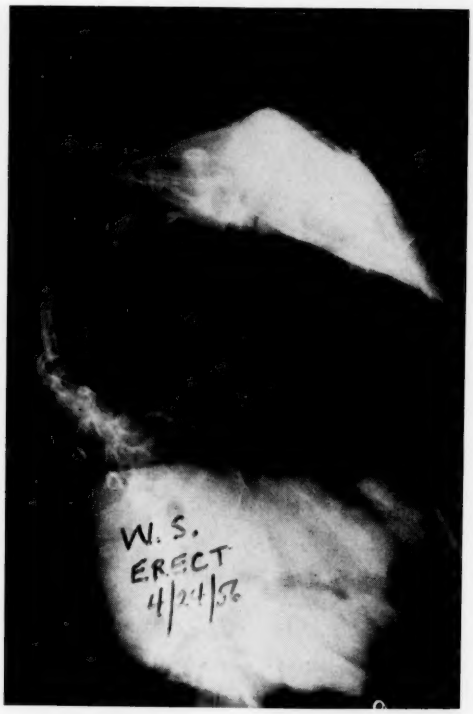


Fig. 3.—Lateral roentgenogram of the same patient illustrating serious collapse of the trunk and rigidity of skeletal deformity.

transfer of the iliopsoas and adductor muscles, provide increased function of hip musculature to improve walking ability.

A recent report by Norton and Foley[12] indicates what can be accomplished. Of 48 patients in the study, 41 were still living at an average age of 15.5 years. Six patients had survived to the third decade. Twenty-six of the 48 had good balance and only 9 were nonambulatory. A total of 144 surgical procedures had been performed on this group and contributed greatly to their improvement.

Spinal Cord Injuries.—This type of injury results in disabilities of bladder and bowel control including the formation of urinary calculi, changes in sensory function, and paralysis in varying degree according to the level and extent of injury. Serious injury in the lumbar area produces a paraplegia with sensory and genitourinary complications similar to spina bifida and is amenable to the same medical and orthopedic care. Apparently, if the injury occurs before growth is completed, the secondary changes of contracture and deformity can compound the disability as in polio and spina bifida.

The same report by Norton and Foley included 17 paraplegic individuals whose disability was acquired in childhood. Sixteen were still living and the average survival time in the 9 oldest patients was 14 years from the onset of paraplegia; the eldest was 30 years of age. Of these, 6 patients were capable of

total self-care and were self-supporting. Four others could care for themselves but were only partly self-supporting. Only 2 were still in institutions.

Injuries to the cervical spine are understandably more incapacitating, resulting in quadriplegia. The neurologic lesion is usually incomplete and in addition to dysfunction of sensation and bladder and bowel control, commonly varying degrees of spasticity occur. Here prognosis for life is more guarded but again depends greatly upon the meticulous attention to general medical and urologic treatment throughout life. Also because of involvement of the intercostal muscles, respiratory function is impaired proportionately and pulmonary infection assumes a serious complicating role.

A survey by Comarr and Kaufman[3] of 116 patients with cervical cord injuries indicates what can be expected from modern complete treatment. When reviewed 9 or more months after injury, an average of 25 per cent had shown improvement and approximately 10 per cent had become able to walk. Unfortunately recovery of bladder and motor control occurred in less than 5 per cent of the cases. Nonetheless when the neurologic lesion is caudad to the fifth cervical vertebra most patients are capable of essential self-care and some become self-supporting. The inadequacy of bladder and bowel control presents a severe barrier to successful social and employment adjustment.

ol. 13
1961

THE NECESSARY APPROACH

From this brief inquiry certain essentials emerge as prerequisites to the successful management of these neuromuscular problems with advancing years. The nucleus is the individual who is the patient, encircled by the family, medical group, and the community. All of these must be included in the continuous total care program, but at a given time one or another may assume a position of greater importance during a particular period.

The Steps.—Rehabilitation is a philosophy in action; it should begin as soon as possible and be enlarged progressively as needed. The physician must bear in mind a long-term viewpoint and be responsible that all aspects of the patient's needs are accounted for. This generally requires more than any one person can provide; often many specialists and particularly trained personnel working in facilities physically equipped for all modalities are needed. There must be careful evaluation and re-evaluation so that the proper prescription for treatment can be given. There must be close cooperation by all concerned and an understanding of the anticipated goals and the successive steps in reaching them. Ultimately the patient must be as capable as possible of living successfully within the limitations imposed by the disability and his environment.

CONCLUSION

Paralytic poliomyelitis, spina bifida, and spinal cord injuries are representative neuromuscular disorders for which modern treatment can make the difference between a dependent cripple and a well-adjusted, self-supporting individual. Life expectancy has been increased, and each year must witness the avoidance of preventable secondary disabilities both physical and mental. Moreover, every

remaining attribute must be developed as completely as possible. The result will justify Sir Francis Bacon's statement regarding those with physical handicaps: "Let it not be marvelled if sometimes they prove excellent persons."

REFERENCES

1. Barker, R. G., Wright, B. A., Myerson, L., and Gonick, M. R.: Adjustment to Physical Handicap and Illness—A Survey of the Social Psychology of Physique and Disability. Social Science Research Council. New York, 1953.
2. Census and Industrial Survey of the Physically Handicapped in California. California State Department of Education, Bul. 9, May 1935.
3. Comarr, E. E., and Kaufman, A. A.: A Survey of the Neurological Results of 858 Spinal Cord Injuries. J. Neurosurg. **13**:95, 1956.
4. Dietrick, J. E., Whedon, G. D., and Shour, E.: Effects of Immobilization upon Various Metabolic and Physiologic Functions of Normal Men. Am. J. Med. **4**:3, 1948.
5. Gordon, E. E.: Physiological Approach to Ambulation in Paraplegia. J.A.M.A. **161**:686, 1956.
6. Gucker, T., III, and Caro, C. C.: Unpublished data.
7. Kammerer, R. C.: An Exploratory Psychological Study of Crippled Children. Psych. Record, **4**:47, 1940.
8. Lowman, C. L.: Survey of the Vocational, Educational, and Social Status of Poliomyelitis Patients, Conducted by the National Foundation for Infantile Paralysis. Transcript, 1942.
9. Lowman, C. L.: What Becomes of Infantile Paralysis Victims. Hygeia, **23**:24, 76-77, 1945.
10. Lowman, C. L., and Seidenfeld, M. A.: A Preliminary Report of the Psycho-Social Effects of Poliomyelitis. J. Consult. Psych., **11**:30, 1947.
11. Luck, J. V.: Traumatic Arthrofibrosis. Instruct. Course Lect., Am. Acad. Orthop. Surg. *X*, Ann Arbor, 1953.
12. Norton, P. L., and Foley, J. J.: Paraplegia in Children. J. Bone & Joint Joint Surg. **41A**:1291, 1959.
13. Pusitz, M. E.: Life Expectancy and Morbidity in Post Poliomyelitis. J. Insurance Med., **4**:27, 1949.
14. Simonson, E., and Keys, A.: Working Capacity in Patients with Orthopaedic Handicaps from Poliomyelitis: Energy Expenditure in Walking at Various Speeds and Grades. Am. J. Physiol., **151**:405, 1947.
15. Taylor, H. L.: Physiologic Effects of Bed Rest and Immobilization, Phys. Med. and Rehab. for the Clinician. Philadelphia, 1951.

Vol. 1
196

OSTEOARTHRITIS

WILLIAM J. TOBIN, M.D.
WASHINGTON, D. C.

(Received for publication March 6, 1960)

THE number of people who have arthritis is not known. In many the symptoms are minor or absent. The estimate of individuals who have some type of arthritis or "rheumatism" is staggering. It has been estimated that approximately 25 million persons in this country have some degree of osteoarthritis or degenerative arthritis.

Osteoarthritis is essentially a degenerative process, widespread in its distribution, yet most prevalent in weight-bearing joints. Osteoarthritis is relatively rare in the wrist, elbow, and shoulder joints unless there has been a definite trauma to the joint. While generally associated with advancing age, the degree of degenerative changes in many specific instances is far out of proportion to the chronologic age of the individual. The question often is asked: "Does osteoarthritis develop in a normal joint?" While difficult to substantiate or prove, it is believed that definite mechanical factors, often unrecognized, pre-exist and predispose a joint, or multiple joints, to develop degenerative changes. That excess weight is a contributing factor in the osteoarthritis of the weight-bearing joints is easily appreciated by the partial, yet significant, symptomatic relief experienced after loss of weight.

While this paper is concerned with a discussion of osteoarthritis, it is realized that often there exists in a joint or joints a "mixed" type of arthritis, characterized by the symptoms, and physical, laboratory, and roentgenographic findings of rheumatoid as well as osteoarthritis.

Any paper dealing with a subject as broad as osteoarthritis must necessarily treat the subject in a general manner. In a sense, osteoarthritis is an incurable disease, and all known methods of treatment are designed to eliminate or lessen the symptoms, and limit the progression of the degenerative process.

The following is a review of the more important basic underlying gross osteopathologic changes in osteoarthritis and osteophytosis, or spondylophytosis. No attempt is made to describe the microscopic changes in the synovium, periarticular soft structures, etc. It is felt that an understanding of the gross osteopathologic changes will be of assistance to the reader in a better appreciation of the progress of the degenerative changes and the rationale of the various methods of treatment.

Supported in part by a grant from The National Foundation.

The anatomy of the normal joint may be discussed briefly. A typical diarthrodial joint is a freely movable joint lined with synovial membrane. The bones making up such a joint are cancellous in nature, having a thin cortical layer and a subchondral plate on which is the articular cartilage. The movable portion of the joint is covered with articular hyaline cartilage which in its normal state is smooth and glistening. (See Fig. 1.)

OSTEOARTHRITIS

Early Stage.—The early stage of osteoarthritis begins with initial changes in superficial articular cartilage, from wet, smooth, glistening, and white, to dry, dull, and yellowish. There is fissure formation, flaking and fibrillation (degeneration of hyaline matrix with resultant loss of binding substance between collagenous fiber bundles), early subchondral sclerosis and condensation, and increased density of bone at weight-bearing areas. Proliferation of fibrocartilage from tissue walls may be extruded to form a "loose body," but there is no marginal hyperplasia at this time, there are no capsular changes, and the condition is usually asymptomatic. (See Fig. 2.)

Moderately Advanced Stage.—In the moderately advanced stage the cartilage becomes thinner at points of weight-bearing and at the points where friction is greatest. Marginal hyperplasia and osteophytes begin to appear at the junction of perichondrium and periosteum. Capsular changes begin and there is hyperplasia with villi and folds. Osteochondromas form in the capsule and may be replaced in the bone. Osteophytes form in the cartilage and are sometimes transformed in cancellous bone, causing early alterations in contour of articular cartilage and molding of bone ends. At this point there are usually some symptoms. (See Fig. 3.)

Advanced Stage.—The advanced stage commences with complete loss of cartilage with eburnation of exposed bone. The cortex becomes smooth and polished and is often grooved. There is progressive marginal hyperplasia and enlargement of marginal osteophytes which may become exostoses, the cancellous bone of which is continuous with the marrow of the major bone involved. Progressive changes in the capsule with a loose body formation, as well as fractured marginal exostoses or detached synovial chondromas or osteochondroma are often present at this stage of the disease. Subchondral cysts containing mucoid material in areas of sclerosis, subchondral minute fractures, and progressive changes in the contour of the joint are seen. The symptoms vary with the extent of the changes and the joint involved. (See Fig. 4.)

Roentgenographic Changes.—In the early stage of the disease roentgenographic findings are usually negative since changes are limited to superficial layers of articular cartilage. When the disease becomes moderately advanced, however, narrowed joint space, the beginning of marginal osteophytic formation, and an increased density in subchondral bone at the site of greatest pressure can be seen. In advanced cases progressive narrowing of the joint and increased marginal osteophytic formation can be detected, and osteochondromas may appear in the capsule.

Eburnation, the result of erosion and wearing away of the articular cartilage

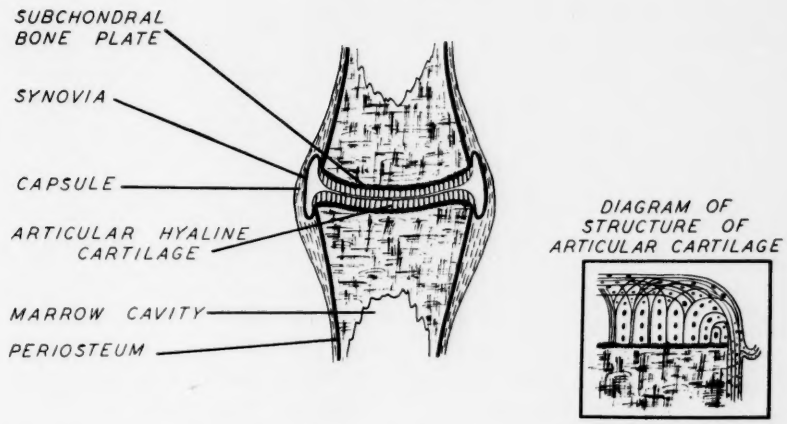


Fig. 1.—Diagram of mechanical conformation of a normal joint. Note subchondral bone plate.

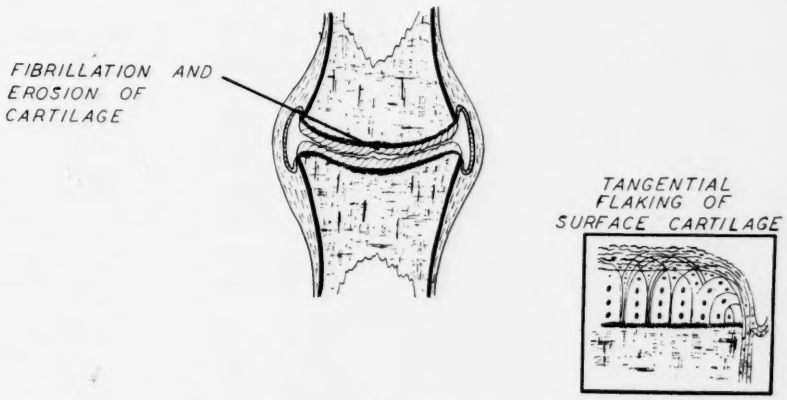


Fig. 2.—Diagram showing fibrillation and erosion of cartilage in early osteoarthritis.

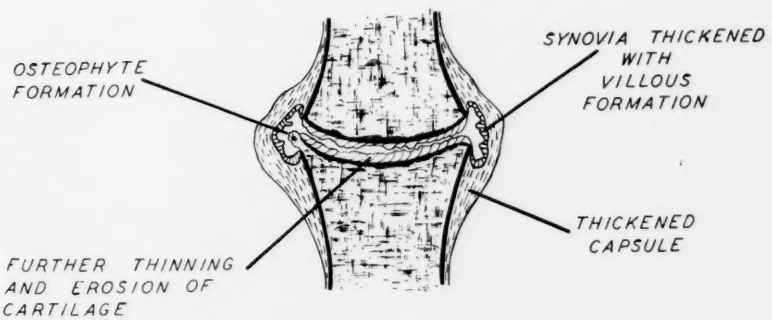


Fig. 3.—Advanced osteoarthritis. Note osteophyte formation, further erosion of cartilage, thickened capsule, etc.

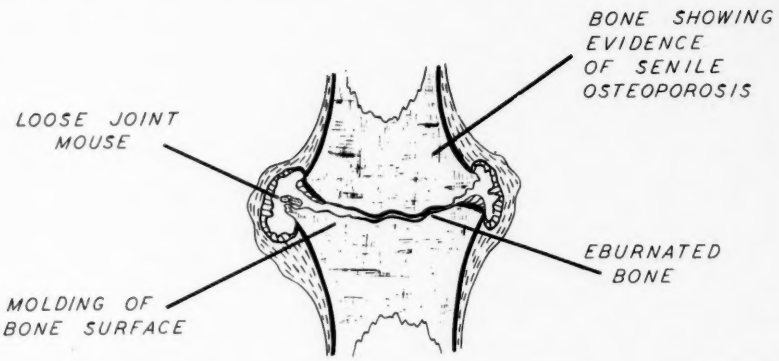


Fig. 4.—Far-advanced osteoarthritis. Ankylosis does not occur as in rheumatoid arthritis. Note "mechanical molding" of adjacent bone surfaces.

with resultant polishing of the subchondral bone, is a common finding in osteoarthritis (Fig. 5). Marginal hyperplasia, roughening of the articular surface, and subchondral cystic changes are also frequent findings of osteoarthritis.

Fig. 5.—Anterior view of distal end of left humerus. Example of wearing away of articular cartilage and "polishing or eburnation" of underlying subchondral bone plate.

Osteophytosis or spondylophytosis should be included in any paper dealing with osteoarthritis. This is a degenerative process involving the intervertebral space, characterized roentgenographically by multiple spur formations arising from the anterolateral aspect of the vertebral bodies. In the dorsal spine, where there is relatively little motion, the osteophytes may fuse together, whereas in the cervical and lumbar areas of the spine the osteophytes seldom coalesce or fuse one to the other. It is interesting that in the dorsal spine the osteophytes are predominantly on the right side, presumably because of the presence of the heart and great vessels on the left.

Osteophytosis.—Osteophytes, which are composed of new periosteal bone, are usually multiple, although they may occasionally appear singly on only one

side of the vertebral column. Since they frequently present no symptoms osteophytosis is often an incidental finding of routine roentgenography. It is, however, usually associated with narrowing of the intervertebral space. The disease may be anterolateral rather than anterior, and the osteophytes may or may not be joined together. The space between two "kissing" osteophytes usually contains disc material, and osteophytosis is caused by the degeneration and "flowing" anteriorly of the disc material. Forward protrusion of the disc is prevented by the firm anterior ligament. Osteophytes rarely form on the posterior surface because the collapsed disc compresses anteriorly. Osteoarthritis is not necessary to the formation of osteophytes of the vertebrae. Indeed, osteophytosis is often confused with true osteoarthritis, even though the only connection between the two is that both occur in the later years of life. Osteoarthritis can occur only in apophyseal joints or facets which are true diarthrodial joints containing synovial membrane (the intervertebral "joint" is a secondary "cartilaginous joint"). The upper part of the spine shown in Fig. 6, clearly illustrates osteophytosis. It can

Fig. 6. Lateral view of dorsal spine with osteophytosis, or spondylophytosis. Note osteophytic outgrowths between upper 2 vertebrae. Other osteophytes are also present. Results from intervertebral degeneration.

be seen that grossly the articular facet is uninvolved. Among the many names given to osteophytosis are: spondylitis osteoarthritica (Knaggs), polyspondylitis marginalis deformans (Shore), spondylitis deformans (Benecke), and spondylosis deformans (Schmorl).

In summary, the protuberances consist of new periosteal bone and rarely form on the posterior surfaces because the intervertebral disc material is compressed anteriorly. It may be said that the intervertebral space is not a true joint from the anatomic viewpoint. It is a secondary "cartilaginous joint" and not a diarthrodial joint containing synovial membrane. It is believed that disc degeneration is the most likely etiological factor in the formation of osteophytes. As the disc material flows anteriorly, the periosteum is elevated and new bone is laid down.

There is little doubt but that with the lessening of the vertical height of the intervertebral space there is a resultant "counter sinking" of the articular facets, the true diarthrodial joints of the spine, with osteoarthritic changes in these small joints. With this mechanical process there is a narrowing of the intervertebral foramina with pressure on the nerve roots.

TRAUMATIC ARTHRITIS

According to Doub, the words "traumatic arthritis" are interpreted as those chronic changes in and around the joint after injury that resemble or simulate the arthritis commonly classified as hypertrophic, degenerative osteoarthritis and arthritis deformans. For practical purposes, and from an underlying basic pathologic aspect, traumatic arthritis and osteoarthritis may be used interchangeably.

Any fracture near or in the articular surface of a joint may result in osteoarthritic degenerative changes developing within the joint. Even though the fracture may not involve the joint, but be adjacent to it, the malalignment resulting in some degree, however little, from a malunion of the corresponding surfaces constituting the joint is conducive to developing osteoarthritic changes. A fracture of the proximal end of the tibia, although united, but in a malposition, resulting in a knock knee or bowleg deformity, may constitute the mechanical basis for a subsequent development of degenerative changes in the knee.

Fractures of the patella, even though repaired by open reduction and internal fixation, may result in a roughening of the undersurface of the patella and be a significant factor in the development of osteoarthritis of the knee. At times a patellectomy is preferable to an attempted repair of the fractured patella because of the inability to bring about a smooth alignment of the undersurface of the patella.

The "dashboard" type of injury which presents the usual clinical picture of a posterior dislocation of the hip associated with a fracture of the acetabulum may result in a latent type of degenerative arthritis.

Fractures of the os calcis with an interruption of the subastragalar joint, a significant weight-bearing joint, are often associated with latent osteoarthritic changes.

It is felt that aggravation of pre-existing osteoarthritis may continue from one week to several years. A formula whereby the extent of the aggravation of the pre-existing arthritis could be established would be highly desirable. There is little doubt that trauma will aggravate symptomatically osteoarthritis existing in peripheral joints as well as in the spine. It is to be expected that few individuals

who suffer back injuries will admit having had any distress or disability before the accident. A patient with pre-existing osteoarthritis who is involved in a relatively trivial accident may complain of symptoms out of proportion to the objective findings. It is admitted that the spine presents quite a problem from the viewpoint of assessing the possible aggravation of a pre-existing osteoarthritis. Of all the portions of the body the back is the anatomic region wherein lies the greatest challenge to the physician in the assessment of disability. A workman injurying his back by simply leaning forward and picking up a heavy object may complain for months of his back, basing his complaints on the individual single incident, and denying that he had any previous difficulty with his back. The necessity of recording in detail the clinical history cannot be overemphasized.

As stated previously, in general the changes which develop in traumatic arthritis are comparable to those in hypertrophic arthritis. Hypertrophic arthritis is likely to be generalized, and is a normal physiologic degenerative process. Traumatic arthritis, on the other hand, is localized to the joint which had been subjected to a definite injury or repeated minor injuries. The extent to which injury can aggravate an already existing arthritis is of particular importance in the evaluation of these cases.

It is a challenge to the physician to differentiate between the acute symptoms which follow any injury to a joint, whether there is arthritis or not, and the more permanent, lasting type of symptoms that would suggest some pre-existing arthritic changes. Many cases are seen in which the acute response to the injury subsides with no lasting disability. It is the consensus among authors that injury to the cartilage is the principal underlying factor in the development of traumatic arthritis. As mentioned above, it is most difficult to evaluate the time element in the development of changes resulting from injury. The judgment of the physician must be influenced by many factors. If, years after an injury, a joint develops arthritic changes they are most likely of a nontraumatic nature. Changes occur in joints as a result of abnormal stresses and strains. The spine, particularly, is subject to degenerative changes in advancing years. These are most likely to be generalized and to involve large segments of the spine. On the other hand, if the changes are localized and there is a definite history of an injury to a particular portion of the spine, the cause or relationship must be carefully evaluated. In cases in which x-rays for some reason have been taken before the injury to a joint, the evaluation of the relationship between injury and later joint changes is much more definite.

It is a known fact that the clinical findings and symptoms are not in direct proportion to the roentgenographic evidence of degenerative changes in a joint. Cases with severe degenerative changes may show slight or minimal symptoms and clinical findings.

The smooth, gliding, well-fitting surfaces of a joint are masterpeices of architecture and mechanics. When any condition brings about a change within the joint resulting in irregularities of the joint surfaces, this relationship is disturbed.

With more persons living a longer life, the problem of degeneration or osteoarthritis is ever increasing. Simple trauma such as a sprain to an arthritic joint may result in disability far out of proportion to the extent of the initial injury.

The mechanism of a sprain in an arthritic ankle may cause more disability than a fracture in or near an otherwise normal ankle joint. Fractures into joint surfaces or near joints that cause a malalignment of the joint surfaces are prone to result in progressive degenerative changes within the joint.

Depressed fractures of the tibial plateau will result in inequality of weight bearing of the femoral condyles on the tibial plateau and result in eburnation, sclerosis, and degenerative changes in the knee.

Fractures of the head of the radius, although the fragments may remain in good position, will often bring about degenerative changes in the capitellum of the humerus.

It must be remembered that any fracture that extends into a joint line and brings about a dissolution of the continuity of the cartilage may ultimately result in a traumatic type of arthritis. As a rule, the degree of osteo- or traumatic arthritis is directly in proportion with the amount of displacement of the fracture, particularly in weight-bearing joints.

A convincing example of the result of malignment of joint surfaces as a causative factor in degenerative arthritis is seen repeatedly in cases of knock knees, or bowlegs which have begun in childhood, but as time goes on, with the resulting malalignment, there result degenerative changes in the articular surface.

Traumatic arthritis results from any alteration of contour of joint surface, such as: (a) hip dysplasia; (b) Legg-Perthe's disease; (c) Freiberg's disease; (d) Köhler's disease; (e) Kienbock's disease; (f) slipped femoral epiphysis; (g) fractures into joint surfaces, such as depressed tibial plateau; (h) osteochondritis dissecans, with loose body causing a defect in articular surface.

Osteo- or degenerative arthritis is a disease of middle age and is seen most frequently among individuals who have performed manual labor, or who have had some static deformities, with resulting unusual strain upon the involved joints. Degenerative arthritic changes are seen frequently in the spine. Because of the changes that occur in the intervertebral space, osteophytes form around the vertebral margins.

It is well recognized that trauma to joints may result in latent degenerative changes in the joints. This is the type classified as "traumatic" arthritis, or osteoarthritis. In discussing the subject of the relationship of trauma to arthritis the difficulty of evaluating the relationship of trauma to the arthritis is apparent. There is always the factor of the physiologic progress of the arthritis with or without trauma. Trauma may aggravate a pre-existing recognized case of arthritis, or may "activate" an otherwise nonsymptomatic, dormant arthritis. The difficulty arises in assessing the relative disability attributed to an injury when arthritis is known, or even not known, but later discovered.

That trauma can aggravate pre-existing arthritis, of either the rheumatoid or osteoarthritic type, is frequently confirmed by the apparent "flare-up" of arthritis in the small finger joints in a person who has had a fracture of the wrist. The surgeon is always aware of this possibility in the treatment of fractures in an individual with known arthritis.

Shorbe and Harsa discussed the magnitude of arthritis from a social and economic viewpoint. They stated that approximately 97 million workdays annually

are lost by self-employed arthritic persons. Many persons who have arthritis attribute the arthritis to an injury, but actually there has occurred an exaggeration or acceleration of a pre-existing arthritis. They, too, stated that oftentimes arthritis may be present without the individual being aware of the condition.

Hench, in a review of 500 industrial accidents, considered 80 per cent of the patients to show degenerative arthritis, and 50 per cent of these attributed their disability to industrial accidents. As a general rule, throughout the country, Workmen's Compensation Commissions hold that an injury that results in arthritis is justly and fully compensable.

TREATMENT

As there is no specific cure for osteoarthritis the management of degenerative joint disease should be directed toward alleviation of the symptoms and minimizing the progression of the disease. As the weight-bearing joints are most frequently involved, weight control is of unquestioned importance.

Most cases of osteoarthritis are initially seen by the general practitioner and the internist. The patient as an individual must be thoroughly evaluated, and not merely the individual joint involved. A complete physical examination should be carried out. The patient should be adequately informed of the nature of the osteoarthritis and told that his utmost cooperation is essential in the proper management of his disease. All etiological contributory factors should be removed to lessen their effects, maintain and improve joint function, and relieve pain. The patient should understand that multiple joints are not likely to become involved as in rheumatoid arthritis. As the basic change is one of "wear and tear," rest to the involved joint is paramount although activity within the limits of pain should be not only permitted but encouraged.

Faulty postural and body mechanics should be recognized and corrected. Orthopedic consultation is often advisable.

In a study of 1,000 patients with secondary degenerative arthritis, Ishmael reported that 70.5 per cent had osteoporosis and 6 per cent osteomalacia. High protein and supplemental protein diets with steroid hormones are valuable adjuncts to other measures in cases with osteoporosis.

The patient should be informed of the necessity of his adjusting his life to his osteoarthritic joint and told that his activities should be governed by his symptoms. Prescribed nontraumatizing exercises are beneficial. Muscle strengthening exercises are of unquestioned assistance in rehabilitating the osteoarthritic patients, but unfortunately most of the cases are in an age group not responsive to muscle exercises.

Cervical Spine.—Neck pain or cervical arthralgia is not an infrequent occurrence in the middle-aged and older groups (Fig. 7). Osteoarthritis is the most frequent etiological factor. The management is conservative. Physiotherapeutic measures are indicated but should be carried out under trained supervision. Neck exercises, and traction first in the physician's office to acquaint the patient in its use, and then carried out on a regular program at home, are perhaps the most valuable of the varied measures used in the treatment of neck pain. As in

the lower back, the degenerative changes that occur in the cervical spine may cause nerve-root pressure and edema of the nerve roots which will, in most cases, respond to traction and intermittent use of a cervical collar. The use of a small pillow that will support the normal cervical lordosis is preferable to the standard pillow that either maintains the cervical spine in flexion or lateral deviation. Physiotherapeutic measures in the form of diathermy, hot packs, etc., are valuable adjuncts in the treatment of cervical arthralgia.

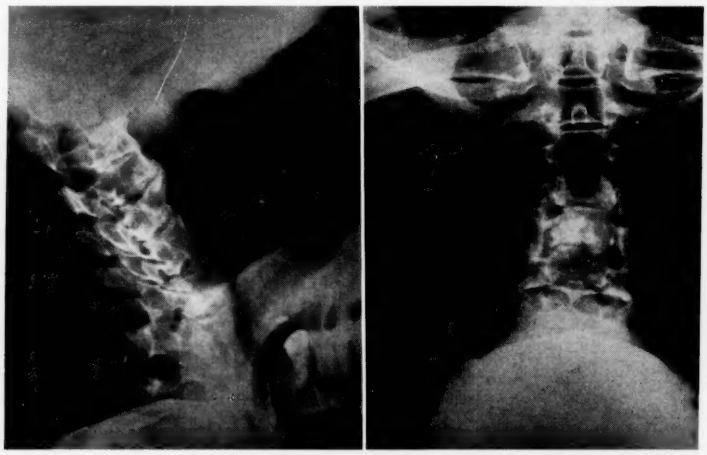


Fig. 7.—Cervical spine showing degenerative changes between the fourth, fifth, sixth, and seventh cervical vertebrae. Associated with narrowing of intervetebral spaces is narrowing of the intervertebral foramina.

Back.—The approach to the symptomatic osteoarthritic spine is mainly conservative. Correction of poor posture is advisable but ineffective, inasmuch as the age group in which osteoarthritis is seen is not adaptable to postural exercises. The routine procedures for the relief of a backache are in order—the use of a firm mattress with a board under the mattress is helpful. A good supporting garment is of value in the symptomatic relief of pain. Any local trigger points of tenderness should be injected with procaine to "break up" reflex pain mechanisms.

Muscle relaxants, which are available in ever-increasing numbers, are valuable adjuncts in the symptomatic relief of back pain.

On the osteoarthritic back an operation is at times indicated. A large osteophyte or spur may project into the neural foramen and cause local nerve-root pressure. If the degenerative changes are posttraumatic and localized to 2 or 3 vertebrae, then spinal fusion may be indicated. Spinal fusion is not indicated in the typical osteoarthritic spine with widespread involvement.

Hip.—Osteoarthritis of the hip may be idiopathic or due to some known etiological factors, such as, congenital dysplasia and dislocation of the hip, direct trauma, slipped femoral epiphysis, or aseptic necrosis of the hip. Pain is the usual complaint, associated with a limp. Often the initial complaint is referred pain in the region of the inner aspect of the knee. Rest of the hip joint by crutches used intermittently or continually until the symptoms subside should be required.

Minor trauma such as a mild sprain may precipitate an episode of synovitis in the osteoarthritic joint.

Physical therapeutic measures consisting of infra-red waves, diathermy, ultrasonic apparatus, massage, and active and passive motions, are beneficial in varying degrees in practically all cases of osteoarthritis. An intelligent, cooperative patient can do much for himself in the form of home treatment with hot baths, moist packs, exercises, etc.

Surgery in Hip Arthritis.—Neurectomies to denervate the joint have not been uniformly successful or widely accepted because of an inability to denervate the joint completely. Subtrochanteric osteotomy to alter the weight-bearing portion of the head of the femur is extremely useful in selected cases. Arthrodesis, the purposeful eradication of the involved cartilage with loss of motion, is the most reliable procedure to eliminate pain and disability in the osteoarthritic joint. This is a major procedure, however, and should be reserved for the selected patients whose future and longevity would justify the prolonged immobilization. Arthroplasties, including the replacement prosthesis, have a definite place in surgery of the hip. Again, proper selection is necessary. Indications for arthroplasty are: (1) bilateral osteoarthritis of the hip; (2) reduced or obliterated knee joint function on the same side; (3) involvement of the lumbar spine with limited motion. A hip with an unsuccessful arthroplasty, except those with a replacement prosthesis, can be arthrodesed.

Knee.—In osteoarthritis of the knee joint, consideration must be given to any associated faulty foot mechanics such as pronation of the feet, with resulting sprain of the medial collateral ligaments of the knee. Corrective shoes with an arch support will often relieve the tension on the medial ligaments so as to relieve adequately the symptoms of minor involvement of the knee. The use of an Ace bandage, elastic knee support, or reinforced hinge will assist in protecting the knee. From the surgical viewpoint, partial or complete synovectomy, combined, if indicated, with a patellectomy, will afford considerable improvement in selected cases that have not responded to more conservative measures.

Foot.—Local osteoarthritis of the first metatarsophalangeal joint, known as hallux valgus, is benefited by the Keller procedure or a resection of the proximal half of the proximal phalanx of the great toe. In essence, this is an arthroplasty.

The local intra-articular injection of corticosteroids often affords marked relief of pain. The response is variable and individual. Dramatic improvement is often seen following a single injection. Some cases require repeated injections, while others do not respond to the intra-articular injection of the corticosteroids.

As the synovium has a low tolerance for infection, the strictest sterile precautions should be used in the injection of a joint. The skin should be prepared as for a major surgical procedure and the syringe and needles autoclaved rather than merely prepared by boiling. A pyarthrosis resulting from improper technique of injection is a disastrous complication. If one is not acquainted with the danger of joint contamination, it is wise not to assume the responsibility. The intra-articular cotricosteroids may provoke a local reaction, manifested by increased discomfort for 12 to 24 hours. The patient should be forewarned as to the possibility of a local flare-up of his symptoms. An ice bag rather than heat to the

involved joint will be of symptomatic benefit following injections if a local flare-up should occur.

Since faulty body mechanics is generally recognized as a major contributory factor to the production of joint degeneration, its early recognition and treatment are important. Poor posture and poor mechanics of the lower extremities should be treated during childhood. Bowlegs, knock knees, pronation of the feet, tight heel cords, etc., can be helped by corrective measures so as to minimize malalignment of weight-bearing joints, a major factor in the wearing and tearing of the apposing articular cartilages.

SUMMARY

Osteoarthritis is a slowly progressive degenerative process involving most frequently the weight-bearing joints. While the exact cause is not understood, the degenerative changes are well recognized. The basic underlying gross osteopathologic changes of osteoarthritis and osteophytosis have been presented to better enable the reader to appreciate the clinical course of the disease. As the condition is incurable and the changes are, in a sense, irreversible, the goal of treatment is directed toward the symptomatic relief and the lessening of the progress of the changes. The proper care of the osteoarthritic patient requires good medical supervision of the individual and orthopedic care of the mechanical factors involved. Because of the controversial status of the effectiveness, in osteoarthritis, of corticosteroids given orally, treatment with these drugs has been omitted with the exception of the benefit derived from intra-articular injections.

The author is indebted to the Division of Physical Anthropology, U.S. National Museum, Smithsonian Institution, Washington, D. C., for the specimens, and to Dr. Darrell C. Crain for the diagrams.

REFERENCES

1. Collings, D. H.: The Pathology of Articular and Spinal Diseases, London, 1949, Edward Arnold & Co.
2. Comroe, B. I.: Arthritis and Allied Conditions, ed. 3, Philadelphia, 1944, Lea & Febiger.
3. Confidential Memorandum to Board of Trustees, The National Foundation for Infantile Paralysis, New York, May 20, 1958, p. 74.
4. Gade, Herman G.: Contributions to Surgical Treatment of Osteoarthritis of the Hip Joint: A Clinical Study, Acta. chir. scandinav. (supp. 120) **95**:1, 1947.
5. Hench, P. S.: Rheumatism and Arthritis; Review of American and English Literature of Recent Years, Ann. Int. Med. **28**:66, 1948.
6. Horwitz, Thomas: Degenerative Osteoarthritis of the Hip Joint, Arch. Surg. **58**:251, 1949.
7. Ishmael, W. K.: Degenerative Arthritis, Am. Pract. & Digest. Treat. **4**:97, 1949.
8. Luck, V. J.: Bone and Joint Disease, Springfield, 1959, Charles C Thomas, Publisher.
9. Neligan, A. R.: The Management of Osteoarthritis, Brit. J. Phys. Med. **1**:100, 1945.
10. Shorbe, B. and Harsa, W. M.: Disability Evaluation in Degenerative Arthritis, *in* Clinical Orthopaedics No. 10, Philadelphia, 1957, J. B. Lippincott Company p. 269.
11. Tobin, W. J., and Stewart, T. D.: Gross Osteopathology of Arthritis, *in* Clinical Orthopaedics, No. 2, Philadelphia, 1953, J. B. Lippincott Company, p. 167.
12. Tobin, W. J., and Stewart, T. D.: Gross Osteopathology, Instructional Course Lectures, Vol. I, Am. Acad. Orthop. Surgeons, Lect. Ann Arbor, 1952, J. W. Edwards.
13. Tobin, W. J.: Relationship of Trauma to Arthritis, Am. Surgeon **25**:332, 1959.

CEREBRAL PALSY

WILLIAM COOPER, M.D.*
NEW YORK, N. Y.

From the Department of Orthopedic Surgery, Hospital for Special Surgery; and the Department of Clinical Orthopedic Surgery, Cornell University Medical College

(Received for publication Feb. 25, 1961)

CEREBRAL palsy is a term which has been assigned to a diverse group of disabilities sharing certain common characteristics. The American Academy for Cerebral Palsy suggests as a definition of cerebral palsy "any abnormal alteration of movement or motor function resulting from a defect, injury, or disease of nervous tissues contained in the cranial cavity, and arising before, during, or soon after birth." Certain additional qualifications might be set down to exclude from consideration disorders which are progressive in nature (such as neoplasms), transient disturbances in motor function (such as Sydenham's chorea), and the nonspecific neuromuscular defects associated with profound mental retardation.

There have been varying estimates of the incidence of this condition. These suggest that there are between 100 and 400 persons who have cerebral palsy in each 100,000 of the general population. Approximately 3 infants in each 1,000 live births will eventually exhibit evidences of cerebral palsy. Despite the uncertainty in establishing a precise estimate of incidence, it is apparent that, with the declining occurrence of poliomyelitis, cerebral palsy is already the major cause of severe orthopedic disability in childhood. Within public school programs designed to serve children with severe orthopedic handicaps, over 75 per cent of the cases are diagnosed as cerebral palsy.

ETIOLOGY

The cause of cerebral palsy cannot be considered separately from the question of reproductive failure or fetal wastage, which has recently come into prominence. This includes all congenital anomalies, as well as abortion, prematurity, stillbirth, and neonatal death. All must be considered to be related in that they are the product of some insult to the developing organism. The damage may occur at any time between conception and delivery, or possibly before conception, and even after delivery. In this broad range of abnormalities, those which involve the brain and affect motor control are grouped in the classification of cerebral palsy.

There is no absolute specificity between the damaging agents and the

*Attending Orthopedic Surgeon, Hospital for Special Surgery; Associate Professor, Clinical Orthopedic Surgery, Cornell University Medical College.

abnormalities which follow. One agent may cause any one of a variety of defects, while, on the other hand, the same abnormality appears to result from wholly dissimilar causes. Rubella infections in the first trimester of pregnancy, for example, may result in such grossly dissimilar defects as heart disease, cataracts, mental retardation, and spasticity; and athetosis may result from causes as grossly different as reduction in oxygen supply, and increase in the pigments of the circulating blood.

In the past, various etiological factors have been considered important as occasional causes of cerebral palsy. These have ranged from protozoan parasites to dietary toxins. From the beginning, however, the principal differences of opinion have revolved around the significance of obstetric factors in the production of cerebral palsy.

Little, in 1861, emphasized abnormal parturition, prematurity, and asphyxia as the usual causes of cerebral palsy. Many years later Freud and others discounted these factors and instead emphasized prenatal factors. In 1926 Ford stated that birth injuries were rare, rather than common, causes of infantile palsies and that obstetric considerations were not of primary importance. From 1925 until perhaps about 1940, it seemed more reasonable and more fashionable to stress congenital, inborn developmental failures as the most frequent cause.

More recent inquires have tended once again to focus attention on birth factors as the principal causes, specifically cerebral trauma and cerebral anoxia. These are the producing or predisposing causes of possibly 50 per cent or more of all cases of cerebral palsy. These two factors cannot always be sharply separated, because trauma may produce hemorrhage which in turn produces anoxia; however, anoxia without trauma may itself cause hemorrhage. Since prematurity is 3 times as common in cerebral palsy as in normal babies, it must be considered a major factor in the production of hemorrhage and cerebral palsy.

Other specific causes of cerebral palsy can be identified. Rh and other incompatibilities in blood type between mother and child, resulting in severe and persistent jaundice in the newborn, have accounted for approximately 7 per cent of a series of 1,000 cases of cerebral palsy studied at the Hospital for Special Surgery. The pigments from the circulating blood are deposited in the basal ganglia with resulting athetosis. With better understanding of the mechanism of this disorder and with improved techniques of exchange transfusion, the incidence of this type of cerebral palsy has fallen, and perhaps it can become a totally preventable disease.

There are a number of prenatal factors which appear to have etiological significance. These include toxemia of pregnancy, abnormal vaginal bleeding during gestation, certain infections (especially in the first trimester), exposure to ionizing radiations, and other factors. Postnatal causes include traumatic brain injuries, encephalitis and meningitis, vascular accidents, and anoxia from carbon-monoxide poisoning and suffocation. Heredity plays a small but significant role in certain cases. The most commonly encountered types of genetically transmitted cerebral palsy are familial paraplegia and familial athetosis. Finally, there are numerous instances where the mechanisms of causation are not obvious despite the most careful inquiry into all antecedent factors.

The available information concerning etiology may be summarized, and it might be concluded that:

Birth and obstetric factors cause 50 to 60 per cent of cerebral palsy.
Rh and other incompatibilities in blood type cause 5 to 7 per cent.
Postnatal factors produce 10 per cent.
Prenatal factors produce 10 to 15 per cent.
Unknown factors are responsible for 15 to 20 per cent.

At the risk of oversimplifying the problem, these factors may be consolidated and considerations made as to how the brain is affected by them. The human brain has a cortex which is exterior and vulnerable to direct pressure or injury from hemorrhage. This is part of the corticospinal tract, and damage to it produces spasticity. Under the cortex are the basal ganglia, which are liable to injury from more subtle causes such as lack of oxygen or the deposition of pigments from the blood. This is the old portion of the brain which is concerned with primitive automatic muscular activities. Damage to it produces athetosis by releasing motor phenomena which are normally kept in check.

This division explains why birth trauma and prematurity produce spasticity, while anoxia and Rh incompatibility produce athetosis. Placenta previa is a specific cause of anoxia and athetosis. Breech presentation may also result in athetosis by interfering with respiration, or it may result in spasticity because of manipulation of the head required during delivery.

There is currently in progress a very comprehensive investigation, sponsored by the National Institutes of Health, into the causes of brain damage. A number of medical centers throughout the country are participating, and will study on an ongoing basis approximately 50,000 pregnant women. The children resulting from these pregnancies will be carefully observed and evaluated for evidences of cerebral dysfunction. Correlations will be made between abnormalities encountered and any potential etiological factors. It is expected that a great deal of useful information will be available on this subject upon the completion of this ambitious and far-reaching project.

In the foregoing discussion reference has been made to only two types of cerebral palsy; spasticity and athetosis. These actually comprise the great majority of cases, spasticity being present in approximately 65 per cent, and athetosis in approximately 30 per cent. The relative incidence, as has been suggested, may vary with the quality of prenatal and obstetric care. If may also vary, of course, with the technical accuracy of the diagnostician.

DEGREE AND DISTRIBUTION OF INVOLVEMENT

Great variation exists not so much in the type as in the degree of involvement and, to a lesser extent, in the areas of the body affected. In both spasticity and athetosis the severity may range from a degree so mild that it may even escape detection by the patient, his family, and the physician, to one so severe that it renders the patient totally and hopelessly disabled. Between these extremes are

every stage and degree of involvement. For convenience and practical usefulness it has always been our practice to consider 25 per cent as mildly involved, 25 per cent as severely or hopelessly involved, and 50 per cent as moderately affected or in the range in which some measure of help can be provided.

The variation in distribution is not so great as in degree, and a title is available for each type. In spasticity, in order of frequency, the distribution is described as: (1) quadriplegia, when all extremities are affected; (2) hemiplegia, when more than one extremity is affected and the involvement is unilateral; (3) paraplegia, when only the lower extremities are affected; (4) triplegia, when three extremities are affected; and (5) monoplegia, when one extremity is affected.

In athetosis, the involvement is ordinarily generalized, but unilateral distribution is encountered in a small percentage of the cases.

Every possible combination of these variations in degree and distribution occurs; actually such combinations represent the principal varieties of cerebral palsy. It is recommended that the diagnosis always be set down in terms of type of cerebral palsy, distribution of involvement, and degree.

There are types of cerebral palsy other than spasticity and athetosis. The classification recommended by the American Academy of Cerebral Palsy includes: (1) spasticity, (2) athetosis, (3) rigidity, (4) ataxia, (5) tremor, (6) mixed forms, and (7) unclassified forms.

In this classification various types of athetosis are also distinguished, depending on their most prominent characteristics. These additional categories include tension, nontension, dystonic, and tremor types of athetosis.

It must be said that this classification is based entirely on the motor handicap which is present. Other areas of involvement, however, occur with great frequency and they should be indicated in any diagnostic formulation. The estimated incidence of the most common associated disabilities is as follows:

Visual	35–50%
Auditory	10–15%
Intellectual	50–60%
Convulsive seizures	30%
Speech impairment	50–75%
Distortion of perception	High incidence
Organic behavior defects	High incidence
Defects in somatic sensation	Uncertain incidence

TREATMENT

To review treatment in its proper perspective, we may for convenience separate the various modalities into groups: (1) physical, including physical therapy, occupational therapy, speech therapy, braces, and appliances; (2) surgical; (3) drug; and (4) psychological and social.

To the largest extent the objectives of management are determined by the degree of involvement. If the three grades of severity outlined earlier are considered, mild involvement indicates an ability to adapt fully to the requirements of independent living, including feeding, dressing, toilet care, and travel. The

second grade, termed moderate involvement, indicates only partial accomplishment of this degree of independence. The third class, severe involvement, designates an individual who is largely or totally dependent and destined to remain so. According to these standards, 25 per cent of the cases are considered mildly involved, 25 per cent severely involved, and 50 per cent moderately involved. Cases considered mildly or severely involved tend to stay the same with some variation in the patients' performance within this group. However, moderately involved cases form a more fluid group. Those so classified can gravitate downward with increasing age and decreasing guidance and become severely involved. This has been the unfortunate destiny of many individuals as they left childhood and became adults. On the other hand, with good treatment they may improve and become more independent, possibly to the point of becoming only mildly involved. The treatment techniques, which are the instruments of improvement, should be initiated early.

The aim of all forms of therapy is of course to accomplish the greatest physical independence consistent with the severity of involvement. The over-all plan may be termed genetic development of function. This corresponds to an old rule that "you cannot walk before you crawl, and you cannot run before you walk." The penalty for not recognizing this axiom is failure.

Physical Therapy.—Certain major levels of function may be set down. In order, the goals are sitting, standing, and walking. Sitting requires muscle power and control in the neck and trunk, plus a sense of equilibrium. The floor, a gymnasium mat, and a suitable chair are the principal devices of treatment. Standing is the next step. In addition to the abilities required for sitting, standing calls for muscle power and control in the lower extremities plus a higher level of equilibrium. Braces, standing supports, crutches, and parallel bars are required at this level. Some measure of arm and hand control is also needed in order to grasp mechanical supports. The next physical level is walking, which requires a higher level of motor control and especially reciprocal movements of the legs. Transportable supports such as walkers, crutches, and canes are required at this stage. Finally, if walking is to have any practical usefulness, the patient must be able to get out of a chair unaided. Beyond this are the devices of a still higher level of practical performance, which include ramps, curbs, and stairs.

In physical therapy, individual therapy is most useful. The needs of the patients are so diverse that group treatment is often wasteful and tends to squander the time of the patient and disperse the efforts of the therapist.

Occupational Therapy.—This is in many respects a sphere of action completely different from physical therapy. Occupational therapy is concerned more with the arms and less with the legs and trunk. Mobility and control are its goal, whereas in physical therapy stability is the objective. In occupational therapy, as in physical therapy, there is a genetic sequence for the therapist to develop. First in the schedule is reaching, then grasping, then opposing, then releasing, and finally supinating. Many instruments of treatment are used in occupational therapy, but they lack even the simple specificity of those used in physical therapy. For the most part they are instruments of daily use plus special media drawn from the ingeniuty of the therapist or from commercial catalogues. Primary

among them are the instruments of daily living. The devices must continuously be changed and varied to maintain interest.

From the very nature of occupational therapy and the social character of its goals, group procedures are easy to develop and are very useful as means of treatment. Individual therapy for specific personal goals is, of course, frequently required.

Speech Therapy.—As in the other kinds of therapy, there is a developmental sequence. Linguistically, this involves crying, progressing to babbling, to imitation of voice sounds, and to a vocabulary of increasing size and complexity.

Speech is a social function to a greater degree than either physical therapy or occupational therapy. It requires an environment and cannot develop without it. The therapist must not only guide the patient through the evolutionary stages of speech, but must also assume the responsibility for working with the persons with whom the patient will have to communicate in his environment.

Bracing.—This procedure represents one of the most effective modalities of management in patients with cerebral palsy. The purposes for which braces are employed include the prevention and correction of deformities; control over involuntary movements; support across weak or unstable joints, where this is required; training in desired patterns of motion; greater ease in handling; improvement in balance; and, at times, preliminary evaluation of the eligibility of the patient for certain surgical corrections. Among the appliances most frequently utilized are short leg braces, long leg braces, double long leg braces attached to a pelvic band with or without spinal extensions, wrist splints, standing tables, relaxation chairs, walkers, and wheel chairs. There are numerous variations among these appliances and many modifications to satisfy individual requirements of patients. The ingenuity of the clinician often governs the success or failure of the device used.

Surgical Management.—This kind of treatment of cerebral palsy may be divided into orthopedic and neurological modalities. Our experience at the Hospital for Special Surgery has suggested that between 15 and 20 per cent of individuals with cerebral palsy may be significantly benefited by orthopedic operative techniques. This opinion is based on 473 procedures carried out over a 10-year period. The most uniformly successful procedures in our hands have been foot stabilization, tendo achilles lengthening, hamstring release, intra- and extrapelvic obturator neurectomy, patellar advancement, hip flexion release, wrist fusion, and pronator release. Other procedures which have been utilized with benefit include rotational osteotomies of the femur, transplantation of the tibialis posticus tendon, and neurectomy of the gastrocnemius. Of these 473 procedures, the end result was rated good in 60 per cent and fair in 26 per cent.

Neurological surgical procedures in cerebral palsy are still considered largely experimental in nature. The value of subtotal cerebral hemispherectomy for control of intractable seizures and disturbed behavior in the hemiplegic patient has been generally well established. Patients have derived spectacular benefit from this treatment, including several in whom the earlier prognosis had suggested a need for permanent custodial care, but who subsequently made normal or near-normal adult adjustments.

The value of stereotactic techniques in the management of congenital dyskinetic disorders is still uncertain. In basal ganglia disease, particularly Parkinson's disease and dystonia musculorum deformans, some measure of success has been reported with destruction of certain portions of the globus pallidus or thalamus by injection of alcohol through a stereotactically placed needle. It was postulated that the globus pallidus exerted an excitatory effect on the cerebral cortex, stimulating it to excessive activity. Removing this source of abnormal irritation might reduce or eliminate adventitious movement. If this were true for other basal ganglia lesions, then it might apply equally to athetosis.

This method has been employed at the Hospital for Special Surgery in a small group of patients. The subjects were athetoid and severely or even profoundly affected. Needles were placed stereotactically in the globus pallidus or thalamus bilaterally and then replaced with polyethylene tubes introduced through the same needles. Absolute alcohol in celloidin was then instilled through the tubes, which were left in place. The injections were repeated in 7 to 10 days through the same tubes if insufficient effect had been obtained. Immediate control of muscle tension and athetosis was evident in one instance to the point of flaccidity. In another, the immediate effect was partial control of athetosis but with some release of underlying spasticity. The effect was hardly considered a great success in these seriously damaged patients and was more interesting than significant. It demonstrated, however, that this procedure represents a powerful device for controlling or modifying motor behavior. The level of its usefulness will to a large extent be determined by the accuracy of its control. It will be explored further at our hospital and in other institutions and may, in the end, yield a real avenue of assistance for patients with cerebral palsy, especially those with massive involuntary movement.

Drug Therapy.—The basic purposes for the use of drugs in cerebral palsy are:

1. To control seizures, which occur in approximately 30 per cent of the cases. This is undoubtedly the area in which drugs are most used and are most useful.

2. To control behavioral disturbances. Drugs may be employed to stimulate the apathetic and to quiet the excited and overactive. They are used to relieve anxiety and reduce emotional tension, for which they are often of great help.

3. The drug action most desired is the control of skeletal muscle tone and involuntary movement. Extensive search has been made for an agent which will act on the central nervous system or myoneural junctions to relieve spasticity, athetosis, and tremor without interfering with volitional movement.

Many drugs have been offered to serve this last function, which is actually our principal concern. Some have been received with great enthusiasm and have enjoyed real temporary promise. With time and experience, the early popularity has in every instance faded and disappeared. This has been true with curare, prostigmin, mephenesin, zoxozolamine, methocarbamol, carisoprodol, and others.

Certainly the search for a drug which will be helpful in cerebral palsy will go on. It is our opinion that some optimism may be preserved for the discovery of a useful agent.

Psychological and Social Therapy.—This last category of treatment is intended to embrace not only the counseling and support often required by patients and their families, but also the variety of special educational, recreational, and vocational services which form an integral part of any comprehensive rehabilitation program. Orthopedic surgeons have dedicated themselves too much to the correction of visible deformity, and in so doing have often neglected the person they were treating. This is particularly true in cerebral palsy. To be sure, the orthopedic aspects are important, but it is really other considerations which impose on the patient with cerebral palsy the dreadful degree of social isolation which is known in no other common medical condition.

Experience at The Hospital for Special Surgery with approximately 1,500 patients with cerebral palsy has compelled us to recognize that the success or failure of these patients has resulted largely from factors other than the physical management, or even the degree of physical involvement. Of these factors, social deprivation, emotional disturbance, and limitation of experience are probably most significant.

There is, in fact, a tendency to regard the person with cerebral palsy almost as a normal person who has some temporary or correctible abnormality. He is regarded as is the child with a fracture who becomes normal when the fracture heals, or the child with a behavior disturbance who might be made normal by some environmental adjustment. Such complete restoration is not usually the case in cerebral palsy. Normal standards of accomplishment generally do not apply, and a special set of criteria and even a special social atmosphere suited to his limited abilities must be established for the patient. On the orthopedic surgeon who treats cerebral palsy, this imposes psychological and social functions and responsibilities.

PROGNOSIS

No discussion of cerebral palsy can be regarded as complete without some statement concerning prognosis. It has been our policy at The Hospital for Special Surgery to make a statement concerning the individual prognosis on the occasion of each medical examination and re-examination. This includes an estimate of eventual ambulation; independence in self-care; language usage; and educational, social, and vocational potential. For a majority of patients, the outlook is unfortunately for continued dependence and custodial care, despite the most aggressive application of all forms of therapy. However, even within this group, there is the possibility of limited independence and vocational activity within a sheltered setting. A significant minority of patients may attain sufficient competence to be integrated into the community as productive and self-sufficient members, capable of commercial employment, normal social relations, and marriage.

INTERPRETATION OF THE LIMP

JAMES P. AHSTROM, JR., M.D.
OAK PARK, ILL.

(Received for publication Nov. 1, 1959)

THE observation of a limp constitutes a sign in the physical examination of the patient. It may be incidental to a broader clinical picture or it may be the main reason that the patient is seeking consultation. In either case a good deal of information may be gained by analyzing and investigating the limp which may be defined as any irregularity of gait.

The causes of limping are many. No attempt will be made to enumerate all of them but it may be helpful to attack the problem on an anatomic basis. By observing a gait, one can often tell whether the main trouble is in the hip, knee, ankle, foot, or back. It is true that all of these areas may be involved or any combination may be affected. In order to analyze a limp the mechanical action at the various joints must be understood. For this reason we will consider our subject first under anatomic headings and then attempt to describe combinations of involvement.

ABNORMALITIES ABOUT THE HIP

Normally when one bears weight upon one foot and swings the other foot through, in order to place it forward, there is a mechanism by which the pelvis on the free side is kept from dropping. The abductor muscles, gluteus medius and minimus, contract, thus tending to approximate the ilium and the trochanter on the weight-bearing side. This keeps the nonweight-bearing side of the pelvis from dropping downward. In this manner one is able to keep the pelvis level during normal gait.

The system of levers operating about the hip joint is illustrated in Fig. 1. It can be seen from this diagram that a normal femoral head sustains three to four times the body weight during ordinary ambulation. The exact amount depends upon the distance of the femoral head, or fulcrum, from the line of the center of gravity as well as upon the body weight and the force with which the foot strikes the ground.

If there is a condition in the hip joint which is painful, if the abductor muscles are weakened, or if the lever arm TF (distance from torchanter to weight-bearing point on femoral head) is shortened, the normal mechanism does not operate. The free, nonweight-bearing side of the pelvis then tends to drop and the patient has a positive Trendelenberg test. This is illustrated in Fig. 2. Where such situations exist, the patient walks with a lurch of the trunk over the weight-bearing

hip. This tends to shift the center of gravity laterally, shortening lever arm FC and thus diminishing the stress applied to the weight-bearing hip.

In paralytic conditions where the abductor muscles are weakened, or relatively inadequate, this type of gait is seen. Poliomyelitis, muscular dystrophy, amyotonia, and cerebral palsy are examples of such entities. Usually there is little or no pain associated with these conditions.

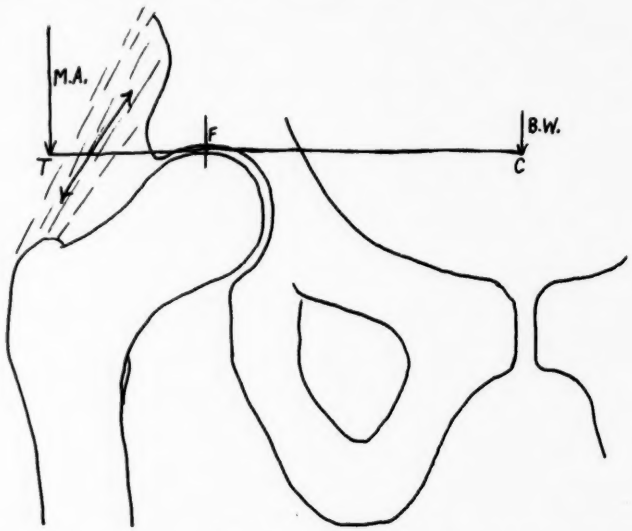


Fig. 1.—Diagram to illustrate the forces acting on the right hip joint. F represents the weight-bearing surface of the femoral head. C is a point in line with the center of gravity. T is a point in line with the greater trochanter where the adductor muscles insert. When weight is borne on the right foot only and the pelvis is kept level, a downward force, BW, is exerted at C. This amounts to the body weight minus the weight of the right lower extremity.

In order to keep the pelvis level, the right adductor muscles must contract strongly enough to result in a downward force at T. If the distance FC is three times the distance FT, this force must be three times BW. The force applied to the femoral head, the fulcrum, is the sum of the two forces BW and MA.

If the adductor muscles are weak, the patient compensates by throwing the trunk, and thus the center of gravity, over the affected hip.

Painful afflictions of the hip joint also produce this type of gait and are often chronic in nature. Rheumatoid arthritis and osteoarthritis of the hip come to mind immediately. These usually occur in adults and are often progressive in nature. In these instances the patient limps on account of pain rather than because of weakness although, in long-standing cases, there may be a combination of these two factors. Relief of pain, and, to some extent, of the limp often can be obtained by surgical measures usually consisting of arthroplasty, or remodelling of the joint.

Joint instability at the hip is also capable of producing a "lurching" type of gait. Congenital dislocation of the hip, dysplasia of the hip in which the acetabulum is more oblique and shallower than usual, coxa vara, in which the neck shaft angle of the femur is decreased to approach or even be less than 90°, and even coxa valga, in which the neck shaft angle is increased, are some of the congenital conditions which produce this gait. Usually these conditions are seen in

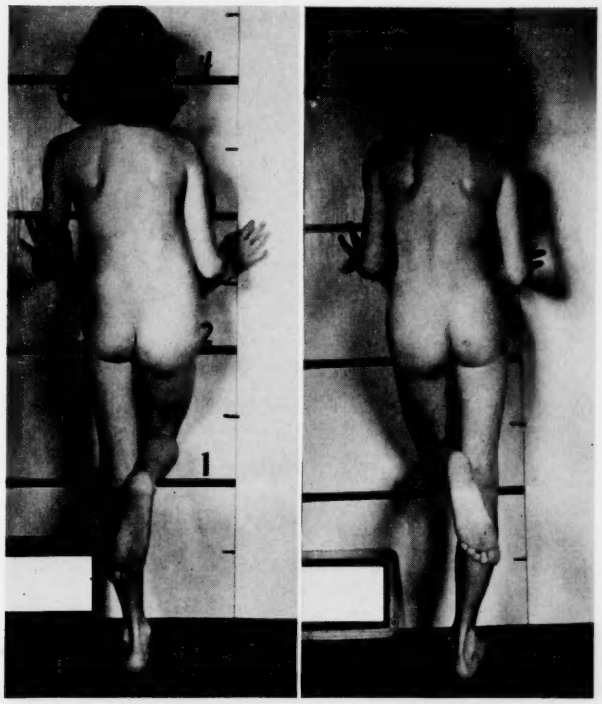


Fig. 2*A*. Fig. 2*B*.

Fig. 2.—*A*, Positive left Trendelenburg sign. As weight is borne on the left foot, the right side of the pelvis drops down.

B, Positive right Trendelenburg sign. The left side of the pelvis drops as weight is borne on the right foot.

Fig. 2.—*C*, Roentgenogram of hips in this patient. There were bilateral congenital dislocations. This patient is now 10 years of age. The acetabuli are shallow and steep and do not form good sockets for the femoral heads. These hips may now be regarded as subluxated.

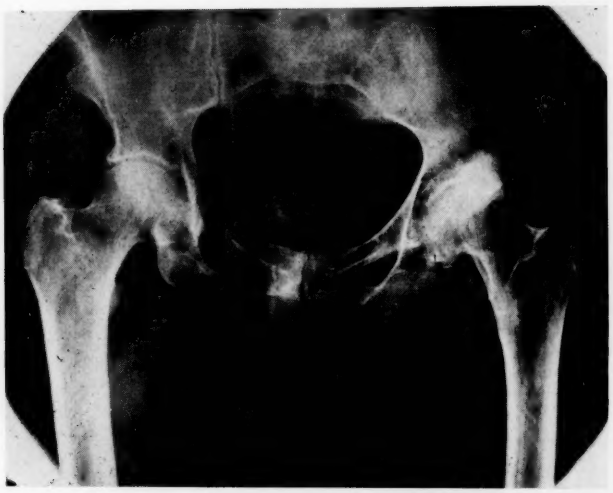


Fig. 3.—Osteoarthritis of the left hip. Over the preceding 8 years this 66-year-old woman had noted increasing pain, stiffness in the left hip after rest, and in the morning upon arising, limp, and insecurity about the left hip. There had been several falls. Motion was greatly restricted and there was a 45° flexion contracture. A cup arthroplasty was done about one month after this x-ray was made. Over the subsequent 2 years the patient improved and the pain has gradually diminished.

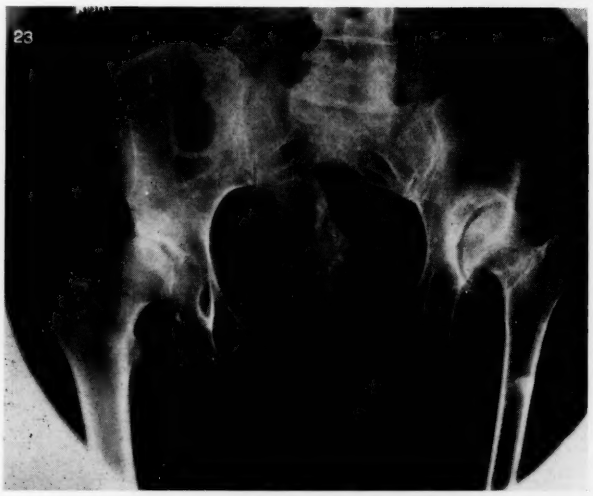


Fig. 4—Congenital dislocation and dysplasia, or subluxation, of the hip with secondary osteoarthritic changes. This 45-year-old woman had a congenital dislocation of the left hip. The left femoral head is engaged in a false acetabulum, which is very shallow and has not developed properly. The right acetabulum is steeper and shallower than normal and there is mild upward and outward displacement of the right femoral head. The right hip could be classified as dysplastic. There are arthritic changes on the right as evidenced by narrowed joint space and sclerosis of bone on both the acetabular and the femoral capital sides of the weight-bearing area. There has been constant pain in the right hip for the past 6 months and it is getting worse. Cup arthroplasty of the right hip has been recommended should the pain become unbearable.

childhood when they are painless. If allowed to progress into adulthood they may become painful and, of course, the limp persists and even becomes worse.

This type of limp may occur in childhood and be painful at the time. Such a situation may occur in Legg-Calvé-Perthes disease, usually seen between the ages of 3 and 10 years, in epiphyseolysis, or slipping of the proximal femoral epiphysis, usually seen at adolescence, or in infectious processes of the hip such as tuberculosis or pyogenic infection.

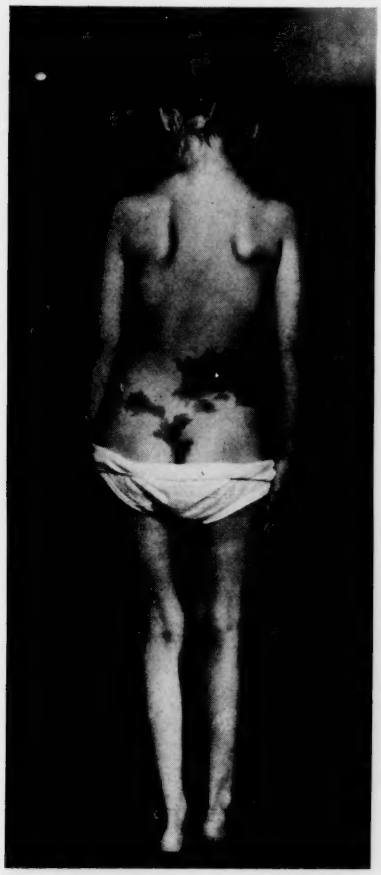


Fig. 5*A*.

Fig. 5*B*.

Fig. 5*A*.—Posterior view of patient 5 years and 8 months of age with Albright's syndrome. Note the irregularly bordered cafe-au-lait spots over the back and the neck.

Fig. 5*B*.—Roentgenogram of this patient's hips. There is involvement of the right femur as shown by irregular radiolucency in the shaft and in the femoral neck and trochanteric area. The coxa vara on the right is not an uncommon finding in this syndrome. This patient exhibited a lurching to the right gait. There may have been an incomplete fracture in the inferior cortex of the neck.

Other conditions involving bone about the hip may produce a lurching type of gait. One might mention such things as fibrous dysplasia, with or without the presence of cafe-au-lait spots, bone cysts, eosinophilic granuloma, bone tumors, Paget's disease, resistant rickets, hyperparathyroidism with its tendency

to form cysts and weaken the bone, osteomalacia, and osteoporosis. Femoral neck fractures of an undisplaced nature may occur and the patient can walk on the limb with the above-described type of gait.

Pain arising from disease of the hip may be felt in the groin or anterior aspect of the thigh. Occasionally it may be felt about the trochanter and, frequently, the patient complains only of aching, but no tenderness to pressure, about the knee. It is not unusual to examine a patient who has been treated for "arthritis" of the knee only to find that the arthritis is in the hip. Along these lines it may be stated that very often patients with hip fractures complain of pain about the knee or lower anterior thigh. Therefore, it is wise to investigate the hip whenever the patient complains of the knee but presents very few local findings about the knee.

The presence or absence of pain with a lurching type of gait may be a clue to the real trouble. If pain is present one may suspect such things as infection, arthritis, tumor, or long-standing congenital conditions which have become painful. In children one would have to consider Perthes disease and slipped epiphysis as well as infection, pyogenic or tuberculous. If there is no pain about the hip one would be more likely to consider paralytic conditions, congenital abnormalities which have not become painful, or perhaps subsiding infectious processes. A painless, lurching limp in an adult could be due to neurologic diseases such as syphilis or syringomyelia, or deformity following fracture.

Occasionally a patient will not lurch directly laterally over the weight-bearing hip but will throw his trunk posteriorly. Generally this is the result of weakness of the hip extensors, namely, the gluteus maximus. If both hip extensors and abductors are weak, he may throw the trunk posterolaterally rather than directly posteriorly or directly laterally.

Flexion contracture at the hip may occur in children as well as in adults. It is frequently seen in arthritic conditions and, of course, in such paralytic entities as poliomyelitis. The patient is unable to fully extend the hip when ambulating. In order to be upright he then compensates by exaggerating the anterior curvature of the lumbar spine. There is thus created an increased lordosis which may be very noticeable. This posture, of course, is often combined with the lurching type of gait.

ABNORMALITIES ABOUT THE KNEE

The stable position, and thus the best weight-bearing posture, of the knee is that of full extension. Impairment of the ability to fully and actively straighten the knee gives rise to instability and a sense of insecurity in regard to the limb. The quadriceps muscle affords the main power of knee extension. In activities which require weight bearing on a partially flexed knee, such as ascending or descending stairs, a good deal of the body weight is sustained by the quadriceps muscle. Weakness of this function causes the patient to negotiate stairs by placing the strong limb forward first and then bringing the weakened limb up to it but not beyond it. Similar difficulty is encountered in negotiating inclines or hills.

A patient with a paralyzed quadriceps muscle may be able to walk very well on level ground. After he throws the foot forward and places it on the ground,

he can stabilize the knee by contracting his hamstrings and gluteus maximus. In effect he forces the femur backward on the tibia in this manner and thus achieves extension and stability of the knee. In spite of this compensation, however, the knee is still weak and is susceptible to twists with resultant ligamentous strains and is particularly prone to "buckle" or give way. In many instances of quadriceps paralysis, the patient is likely to ambulate with his hand on the anterior surface of the thigh. By manually pushing posteriorly he can extend the knee and achieve stability.

Vol. 13
1961

Fig. 6.—Osteochondritis dissecans of the lateral tibial plateau. This is the knee of a 15-year-old boy. The symptoms referable to this joint included locking, i.e., inability to fully extend the knee, buckling, some aching, and a feeling of instability or insecurity. At operation this piece of tissue measured about 2 by 2 centimeters and was attached only at the posterior margin. It was removed. The most frequent location for osteochondritis dissecans in the knee is reputedly on the medial aspect of the lateral femoral condyle in the intercondylar notch.

Conditions which may cause quadriceps weakness or inactivity would include poliomyelitis, spina bifida, muscular dystrophy, cerebral palsy, or injury. One occasionally sees previously unrecognized cases of quadriceps tendon or patellar ligament rupture which exhibit a paralyzed quadriceps type of gait. It is true that many painful conditions in the knee joint will give rise to weakness of the quadriceps with resultant buckling and insecurity. Usually these are traumatic in origin and include such things as torn menisci, loose bodies, osteocartilaginous fractures, and recent subluxations or dislocations of the patella.

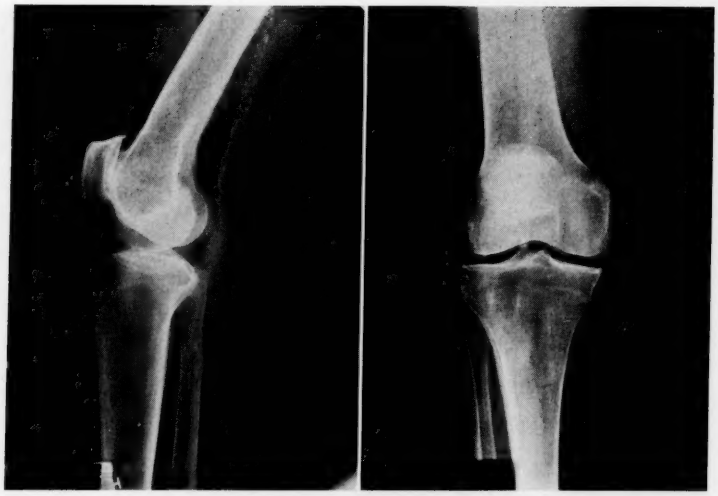


Fig. 7.—Osteoarthritis of the knee. The essential points in roentgen diagnosis include sharpening of corners of the joint surfaces, as can be noted on either side of the tibia on the AP view, decreased space between the femur and patella, and spur, or osteophyte, formation at either end of the patella or at the joint margins. Oftentimes subcortical sclerosis, especially at the posterior patellar border, also occurs. This patient was a 79-year-old woman who had had symptoms for many years. She could not fully extend the knee and noted aching and stiffness after inactivity. There is an apparent loose body in the knee. This could be an osteophyte which has been separated from its attachment. Oftentimes intra articular steroids relieve the symptoms from a joint such as this.

In cases of joint injury there seems to be a reflex relationship which inhibits quadriceps action and produces rapid atrophy of the muscle. This is frequently notable on visual inspection as early as one to two weeks after injury. Osteochondritis dissecans, osteoarthritis, rheumatoid arthritis, and loose bodies from any cause can also have this effect on the extensor mechanism of the knee.

In conditions in which the knee joint itself is primarily affected and especially in painful conditions of the joint, the patient bears weight rather guardedly and keeps the knee flexed. He tends to walk on the forefoot with the heel off the ground and with the hip and knee flexed. He keeps weight on the affected extremity only briefly by quickly hopping on that foot and getting his weight onto the good foot as soon as possible. This is the gait observed in fresh injuries of the joint, such as ligamentous or cartilaginous tears or even fractures of the patella or condyles.

In more chronic conditions such as old cartilaginous tears or arthritis of the knee, the patient also bears weight with the knee flexed. He does not hop as rapidly as the patient with a recent injury but he tends to get his weight off the involved limb and onto the good one with no waste of time. This class of patients often is troubled with giving way of the knee and with inability to negotiate stairs normally. There is pain in the joint and tenderness to pressure is usually present over the medial aspect of the proximal tibia. If the condition has been of long standing there may be an actual flexion contracture.

Tumors about the knee such as osteogenic sarcoma, giant cell tumor, hemangioma, or osteochondromatosis may produce this bent knee type of gait.

Fig. 8.—This 5-year, 10-month-old girl had poliomyelitis at the age of 2 years, 5 months. Most of the paralysis is confined to the right lower extremity. As time passed she developed a rather marked genu recurvatum at the right knee. The muscle power in the knee flexors and extensors is negligible. A brace may have to be used in an effort to prevent too much recurvatum. Fortunately, however, the knee is stable in this position.

Usually there is some swelling present and often there is a significant amount of pain. However, swelling and pain are also present in the more benign condition of osteoarthritis. In adolescents, an intermittent limp with knee pain can arise from such conditions as Osgood Schlatter's disease or osteochondritis dissecans. Because of the wide variety of possible causes, it is always wise to obtain adequate roentgen studies of the joint as well as expert clinical and roentgen evaluation.

ABNORMALITIES ABOUT THE ANKLE AND FOOT

In limps produced by conditions about the ankle or foot the picture may vary according to whether there is pain or paralysis, or both. In painful conditions about the ankle, such as the common sprain, the patient walks with the ankle held stiff, usually with the foot making an angle of about 90° or slightly more with the leg. Since the bearing of weight is painful, he gets his weight off that foot as soon as practical and spends perhaps a little more time on the uninjured foot. Since he has pain with plantar flexion of the ankle he does not use this motion in his gait. As a result his weight is not borne on the forefoot at the end of the weight-bearing phase of gait. Therefore, there is no "take-off" from the injured

foot. Such a patient uses the injured foot as a stump, placing it forward and using it only for a short time until the weight can again be sustained by the uninjured foot. Aside from sprains of the ankle, such a gait can be observed in such conditions as traumatic arthritis of the ankle, osteochondritis dissecans, tenosynovitis about the ankle, osteochondritis of the calcaneal apophysis, rheumatoid arthritis, various tumors, or such conditions in the foot as march fracture, Freiberg's infraction, metatarsalgia, plantar neuroma, Köhler's disease, plantar fascitis, or traumatic arthritis following old injury.

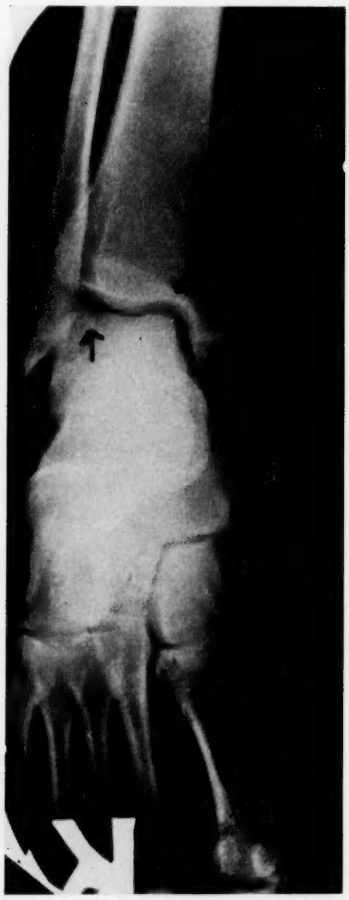


Fig. 9.—Osteochondritis dissecans of the distal tibial articular surface. The arrow on the left (nearest the fibula) points to a loose piece of bone. This has come from the area of the distal tibia indicated by the more medial arrow. This 40-year-old woman did not have a history of any trauma sufficient to cause a fracture. The symptoms of pain and pulling came on suddenly and severely as she was standing watching a parade. On examination there was no obvious swelling. There was pain, however, with passive dorsiflexion of the foot to right angles. The loose piece was removed.

Inability to dorsiflex the ankle produces a drop foot or steppage gait. Because the foot drops into plantar flexion when the limb is raised to take part in the swing phase of gait, the knee must be raised a little higher than usual.

Vol. 13
1961

Fig. 10.—This roentgenogram showing anteroposterior and lateral views of a right foot is a typical example of Köhler's disease of the tarsal navicular. It is dense and appears quite thin in the lateral projection. This is more frequent in boys than in girls, is usually seen between 3 and 6 years of age, and is usually unilateral. The patient exhibits a stiff ankle type of gait and has tenderness over the navicular bone.

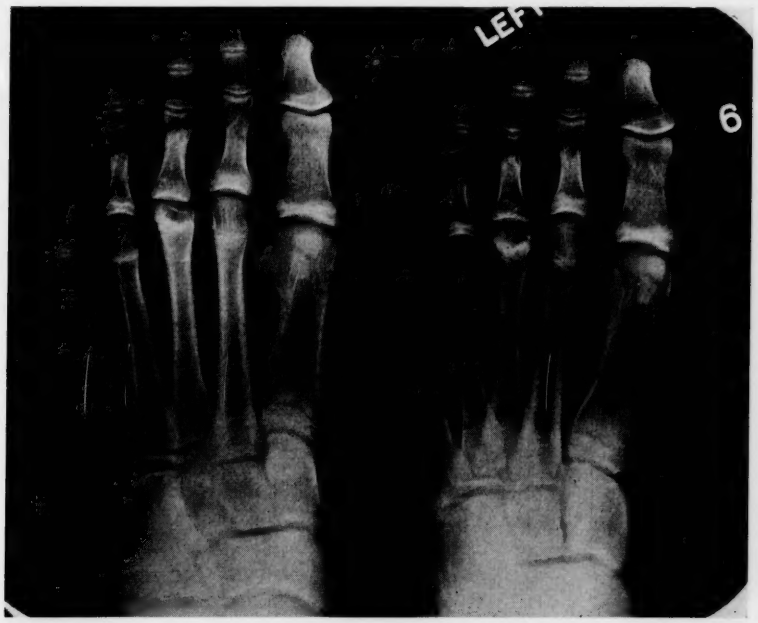


Fig. 11.—Freiberg's infraction. In most instances the second metatarsal is involved. In this case, however, it is the third metatarsal, the head of which is flattened and irregular. Motion at the metatarsophalangeal joint is restricted and extremes of passive motion are painful. There is visible swelling of the toe and there is a palpable bony ridge dorsally. Symptoms are those of pain during and after exercise. Conservative treatment usually is indicated but, if pain and stiffness persist too long and are too disabling, surgical treatment in the form of arthroplasty could be done. Etiology is unknown.

This is necessary so that the toe of the foot does not scrape on the ground. When the foot is placed onto the ground, the patient slaps it down rather than touching the heel first in the usual manner. A slapping gait, commonly described as a dropfoot or steppage gait, is thus produced. Any condition which causes weakness or paralysis of the anterior tibial or toe extensors can lead to this gait. Poliomyelitis is thought of immediately. However, such things as Charcot-Marie-Tooth peroneal muscular atrophy, Friedreich's ataxia, lead poisoning, injury to the peroneal nerve or to the dorsiflexor muscles, and syphilis must not be forgotten.

Inability to plantar flex the ankle leads to a lack of "take-off" in gait. No weight can be borne solely on the forefoot since the triceps surae muscle group is weakened. The patient ambulates much as does a patient with a painful ankle with the exception that he is not in as great a hurry to get his weight off the foot. The involved limb acts as a stump and there is no "take-off". If weakness of the ankle plantar flexors is present long enough, a calcaneus deformity of the foot is produced. The tuberosity of the os calcis drops downward and the longitudinal arch is exaggerated as well as shortened. In some instances a heavy covering of thick skin is located over the calcaneal tuberosity while there may be little or no evidence of weight bearing on the forefoot. The shoe may be worn out on the heel but the sole may be practically untouched. Any condition which inactivates effective plantar flexion can produce this gait and deformity. The list would include poliomyelitis, spina bifida, and injury to the muscle, tendon, or nerve.

In connection with the foot and ankle a few words should be said about congenital equinovarus deformity. This condition can be unilateral or bilateral. Originally it consists of adduction of the forefoot, equinus of the ankle, varus or turning in of the heel, and some amount of internal or medial tibial torsion. If left uncorrected, the patient bears his weight on the lateral aspect of the base of the fifth metatarsal. He toes in and there is no "take-off." In contrast to the calcaneus deformity, the heel remains quite high in position. Fortunately most children with this congenital deformity are channeled to places where some degree of correction can be obtained. It is true that this condition often tends to recur in spite of repeated adequate cast corrections and even operation. It is a rule that persons with this deformity must be followed until maturity since recurrence is so notable. Even in a well-corrected case one may be able to detect some forefoot adduction, perhaps some mild equinus posture at the ankle, or some varus at the heel. Very often persons with this condition will tend to limp even in adult life, if only a fatigue limp or a very minor irregularity is exhibited.

ABNORMALITIES WHICH AFFECT THE ENTIRE LOWER EXTREMITY

Classification of limps and their causes can be done in many ways. So far we have considered abnormalities of gait arising from trouble at a given spot in the lower extremity. There are conditions which by their very nature, however, may involve several areas in the lower extremity or even the entire body. Poliomyelitis is one of these. It has been mentioned as a possible cause in every anatomic location described so far. Of course, more than one area can be affected. For example, a patient could have a "Trendelenberg" gait and a steppage gait in the same extremity. If one goes to the extreme, the entire

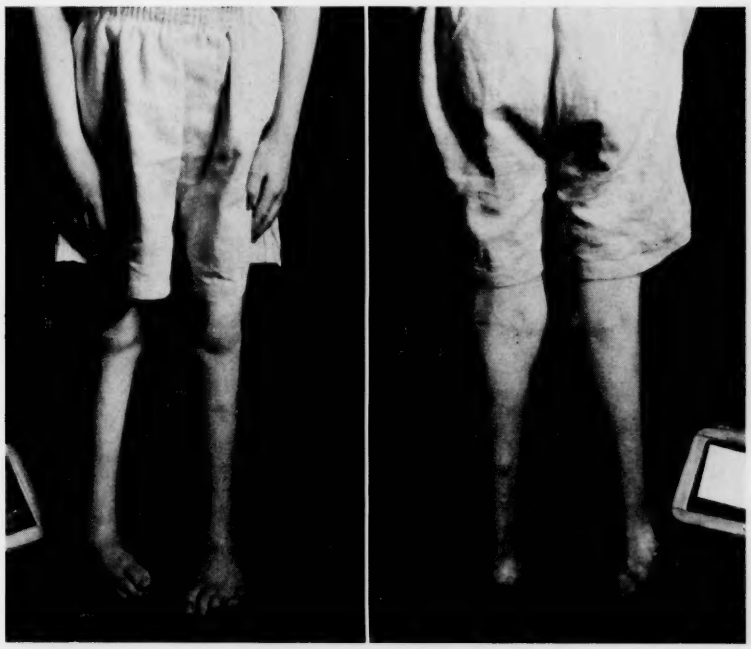


Fig. 12.—Front and rear view of a 9-year-old boy who has congenital equinovarus deformities. The right foot is worse than the left exhibiting varus at the heel, adduction of the forefoot, and equinus at the ankle. Note how the knees face somewhat outward and tend toward a genu recurvatum. Because of limited dorsiflexion at the ankle, these patients will develop some back-knee in an effort to get the heel to the ground.

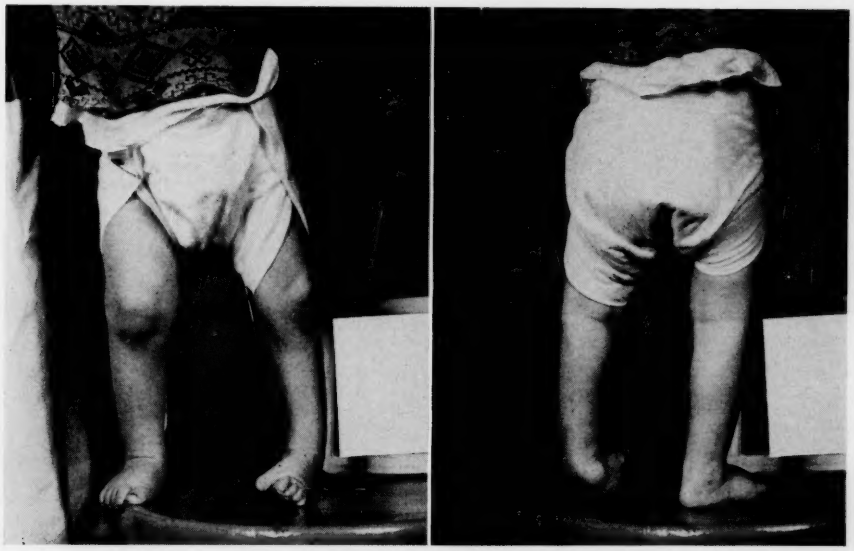


Fig. 13.—This 20-month-old boy, shown in front and rear view, has a left equinovarus deformity, or clubfoot, which has been essentially untreated. Note the inversion of the heel, adduction of the forefoot, and equinus at the ankle.

extremity could be flail and atrophied requiring the use of a brace or crutches or both in order to ambulate. The combinations of possibilities with poliomyelitis as a cause are many. It merely depends upon which muscles or muscle groups are involved.

A. *B.*

Fig. 14.—*A*, This 8-year-old patient has cerebral palsy with spasm of the hip adductor muscles. The left leg crosses in front of the right as she steps forward with the left foot, thus producing a scissors gait.

B, Rear view showing the same patient. As so many of these people do, this girl walks with her knees flexed. Many feel that this posture is assumed in order to achieve better balance. One can also see a positive right Trendelenburg sign and a lateral lurch to the right.

Affections of the central nervous system often produce spasticity with consequent changes in gait. Cerebral palsy and cerebrovascular accidents have much in common. The former occurs at a younger age and, of course, there is yet the factor of growth to reckon with. In each condition, spasticity is not uncommon. Usually the hip adductors, flexors, and internal rotators, knee flexors, ankle flexors, and foot invertors are more powerful than their antagonists. As a result the limb is held in adduction, flexion, and internal rotation at the hip, and weight is borne with the knee and ankle flexed. In extreme cases where both lower extremities are similarly affected, a scissors gait results. The advancing knee crosses in front of the weight-bearing knee and the weight is borne on the inverted forefoot. Since the legs alternately cross each other in ambulating, it is called a "scissors" gait. The degree of limp and deformity, of course, varies with the extent of involvement. In some cases of cerebral palsy, there may be a mild tendency to

bear weight on the toes only when tired. One may note that wear on the shoe is more pronounced on the toe and sole than on the heel. This may be true also of patients who have had cerebrovascular accidents. Times of stress, fatigue, or excitement usually produce the worst gait. It is not unusual to note that the elbow and forearm on the involved side are flexed and pronated, especially when the patient runs or becomes excited. The deep tendon reflexes are exaggerated and usually there are pathologic reflexes and clonus.

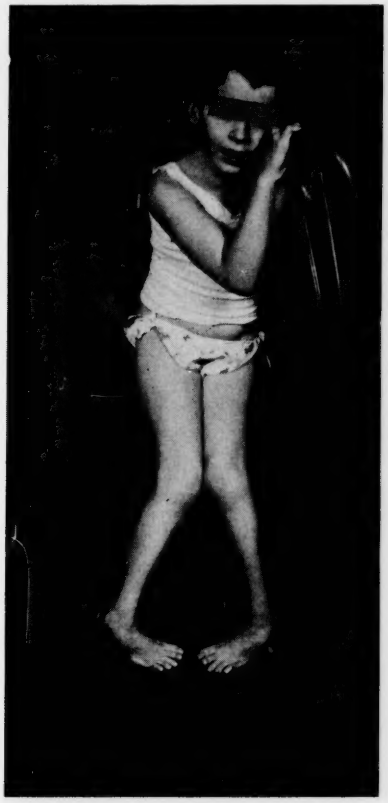


Fig. 15.—This 7-year-old girl has cerebral palsy. Note the adduction of the hips. Spasm of the adductors was later treated in this case by obturator neurectomy and adductor tenotomy. The knees are flexed and the feet are in a position of equinovarus, which is not congenital but is secondary to the muscle imbalance.

In cerebral palsy there are many operations which are employed at opportune times to correct or alleviate defects in gait. Similar procedures can be employed for victims of cerebrovascular accidents. To correct deformity in the foot per se, triple arthrodesis is quite effective. For alleviating an equinus deformity at the ankle, neurectomy of two or three branches to the gastrocnemius may help if there is no structural shortening of the Achilles tendon. If this tendon is short, it can be lengthened. Sometimes both procedures have to be done at the same time. For a persistent flexion posture of the knee, transfer of the hamstring

tendons to the femur is often helpful. To correct persistent adduction of the hip, obturator neurectomy and adductor tenotomy are useful. If there is persistent internal rotation at the hip, derotation osteotomy of the femur is effective. These are only a few of the operations employed in the effort to improve the gait in a spastic individual.

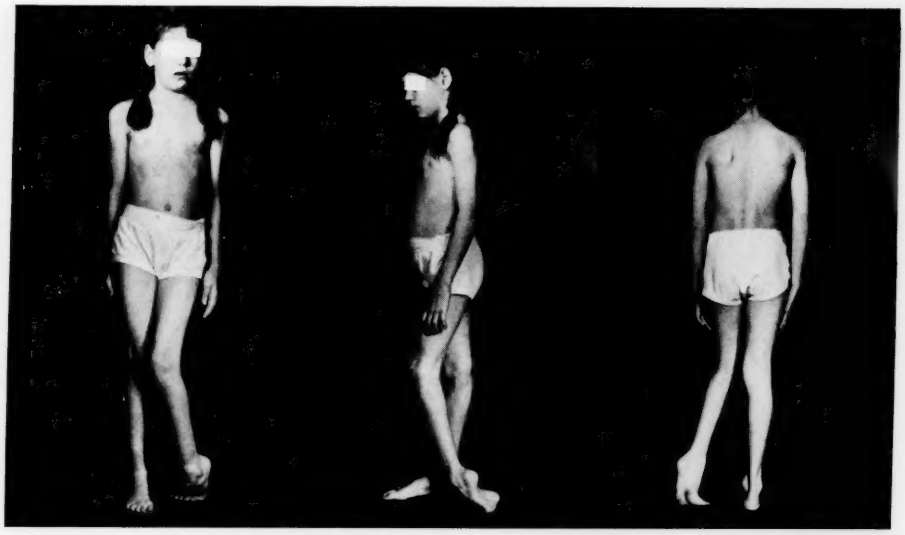


Fig. 16.—Three views. Front, rear, and left side of an 8½-year-old girl who has cerebral palsy predominantly involving the left lower extremity. The left thigh is adducted and internally rotated and the knee is flexed. There is a positive right Trendelenburg sign. There is extreme contracture of the left heel cord preventing the left heel from touching the floor. The weight is borne on the left forefoot. Many times a patient with this type of involvement will also present a pronation posture of the forearm with flexion of the elbow and internal rotation of the shoulder. Surgical measures which one would consider for this girl would include heel cord lengthening and triple arthrodesis for the foot and ankle, and transfer of the hamstring tendons to the posterior aspect of the distal femur to cope with the flexion posture of the left knee.

There are other general types of limps which ought to be mentioned. Very often patients believe they limp because one leg is shorter than the other. In some instances this is true. Most times, however, there is negligible shortening if any. Whenever the muscular control of a limb is impaired it seems shorter to the patient. Causes of actual shortening, however, would include poliomyelitis, infection, or injury when there has been damage to or inadequate stimulation of the growth centers. There is a congenital condition termed hemihypertrophy in which one limb is larger than the other. Usually the upper extremities follow the lead of the lower extremities. Seldom would the leg length discrepancy be over 2 inches. In poliomyelitis or in old pyarthrosis, the discrepancy may be several inches. The same is true in such conditions as pseudarthrosis of the tibia, congenital absence of the femur, fibula, or tibia, and dyschondroplasia. When leg length discrepancy is one inch or more, surgical procedures to effect equalization are justified. Such operations would include epiphyseal arrest in the long limb, shortening of the long limb, and correction of deformity which contributes to the relative shortening of the short limb.

In patients with pain arising in the lumbosacral area, specifically caused by a bulging or herniated intervertebral disc, there is often observed a list to one side. The shoulders are thrown to one side and the arm-waist triangle is enlarged on that side. There appears to be scoliosis. This posture is assumed involuntarily and is attributed to protective muscle spasm. Usually there is pain in one leg, although both can be involved. Such a patient favors the painful leg and thus he limps. Such a limp does not have the characteristics of a real hip, knee, or ankle limp. It is merely a cautious gait employed to protect the involved extremity from pain and is usually accompanied by a list. As the condition improves or gets worse, this limp gets better or worse accordingly. In such a picture one must always investigate the low back very carefully.

A wide-based, unsteady type of gait may be exhibited in several entities. Any condition which affects the balance will cause the patient to compensate by using a gait with the feet wide apart and with a staggering type of placement of the feet. Cerebellar ataxia from such things as tumor, injury, or Friedreich's ataxia will produce this. Posterior column involvement producing loss of deep sensation can cause such a gait. In this instance, the staggering gait is more evident when the patient cannot see his feet. Tabes dorsalis and diabetes mellitus can both produce lesions in this area. Muscular dystrophy and certain types of cerebral palsy may give rise to such a wide-based gait. In the former condition the gait usually becomes worse with time, while in the latter it usually improves.

Neurotrophic joints may be seen anywhere in the lower extremity. The common cause is tabes dorsalis, but other neurologic conditions may also be at the root of the picture. Diabetes mellitus is being recognized more and more as a cause of neurotrophic joints. Spina bifida exhibits them also. Usually, but not always, such joints are painless. There is pronounced ligamentous instability allowing side-to-side motion of the tibia on the femur in cases of knee involvement, hypermobility of the hip if this joint is affected, and extreme passive motion at the ankle and foot if this area is involved. The patient complains of instability rather than pain. The roentgenogram usually shows marked destruction of the joint with bony hypertrophy in the area and perhaps several loose bodies. The roentgenographic changes are out of proportion to the symptoms. Stabilization by arthrodesis or braces is the treatment. Since it is notably difficult to fuse such neurotrophic joints, one often has to depend upon braces.

THE PLACE OF BRACES

So far very little has been mentioned in connection with the use of braces. Naturally in many conditions mentioned braces are useful and necessary. For a drop foot, a brace will hold the foot up and minimize the steppage gait. For a calcaneus deformity, there is no good brace. For weakness of the knee, a long leg brace with a knee lock will afford stability. One of the aims of rehabilitation, however, is to free the patient of his brace. Usually surgical procedures such as tendon transfers, osteotomies, or arthrodeses are employed as definitive measures and would be necessary to replace the function lost by the disease and temporarily afforded by the brace. In some instances braces are used in an attempt to maintain

such correction of deformity as has been obtained. An example would be a right angle ankle brace in cerebral palsy. This may be used only at night or may be worn all the time depending on the severity of the involvement. A long leg brace with a knee lock may be worn to maintain correction of a knee flexion contracture. So we see that braces may be employed to maintain correction, although their larger use lies in affording stability where it is needed.

SUMMARY

Several types of limp have been described. To some extent it is possible to classify limps according to whether the prime difficulty is about the hip, the knee, the ankle, or the foot. In addition, many conditions may involve the whole lower extremity and even the back. Examples of gait produced by such entities have been described. No attempt has been made to list all of the causes of limping. However, in each section several examples of etiology have been mentioned. It must be remembered that a limp is no more than a sign in the evaluation of a patient, just as enlargement of the heart is a sign, or physical finding. To properly evaluate the physical finding of a limp, one must have a working knowledge of normal gait as well as knowledge of pathologic processes which can involve the muscles, nerves, bones, connective tissues, joints, and blood vessels of the lower, extremity and back.

REFERENCES

1. Blount, W. P.: Don't Throw Away the Cane, J. Bone & Joint Surg. **38A**:695, 1956.
2. Fairbank, Sir Thomas: An Atlas of General Affections of the Skeleton, Edinburgh, 1951, E. & S. Livingstone Ltd.
3. Mercer, W. P.: Orthopaedic Surgery, ed. 4, Baltimore, 1950, Williams & Wilkins Co.
4. Watson-Jones, Sir Reginald: Fractures and Joint Injuries, ed. 4, Baltimore, 1955, Williams & Wilkins Co.

Vol. 1
196

LATE RESULTS—GOOD AND BAD—IN THE TREATMENT OF INJURIES TO ATHLETES

DON H. O'DONOGHUE, M.D.
OKLAHOMA CITY, OKLA.

(Received for publication April 29, 1960)

INTRODUCTION

THOUGHTFUL consideration will disclose that there are indeed many injuries to which an athlete is subject which may eventually result in chronic disability. In spite of our past efforts to prevent this sequence of events, it is inevitable that the practitioner will see many elderly patients with disabilities which have been initiated during the more active period of their careers.

No one can seriously doubt that the best way to prevent sequelae leading to chronic crippling is to treat the initial injury. In general there has been a great advance in the early treatment of injuries to athletes. This will, in the long run, result in very much less chronic residual disability. However, many cases of chronic changes are still being undertreated. The examples of this are legion. The 45-year-old athletic hero bragging about the "trick knee" which he has had since high school days is indeed inviting trouble which may well become irremediable as a result of the development of gross degenerative changes. The great majority of these cases could have been prevented by adequate, early, intelligent treatment recommended by the doctor and accepted by the patient.

The vast majority of injuries to athletes occur in young, healthy individuals. These youngsters are particularly receptive to that type of definitive treatment which is designed to prevent permanent disability. One should not be resigned to accept chronic disability as a result of an acute injury. Disability may be unavoidable in some instances, but all too frequently the cause lies not in the injury itself but in its management, either by the doctor or by the patient. Many of the older concepts of athletic sequelae have had to be drastically changed in the light of a more careful analysis. I do not think that anybody is seriously concerned about the "athletic heart" as a cause of decompensation in later life. Certainly the type of reasoning which holds that the ex-athlete tends to get fat because he quits the training to which he has been accustomed is credulous to say the least. If he does have an inherent tendency to get fat, he has at least postponed this adiposity by training during his youth. Actually, the majority of ex-athletes have enough pride in their physical prowess to keep themselves in better physical condition because of the fact that they have been athletes at some time in the past.

With this brief introduction let us consider some of the specific areas of the body which are most prone to injury in the athlete and which are the most likely to be the location of chronic disability in later life.

THE KNEE JOINT

The knee joint is subject to some specific conditions which are prone to cause chronic changes. The knee is an extremely vulnerable joint. It is subject to injury by the very nature of its anatomic structure and particularly because of its exposed position, lying between two long bones, and the great leverage exerted on its ligaments. In a great many cases the original injury or original series of injuries is so poorly managed that chronic changes do result. One of the most common of these is the degenerative change which results from intrinsic injury to the knee. A very common site of difficulty is the medical meniscus. When placed under unusual stress the meniscus tears. There may or may not be episodes of locking. The activity of the patient is decreased to the point where he no longer competes in athletics. Yet, he continues to have a certain level of disability in the joint. The knee joint simply will not tolerate repeated episodes of catching, locking, and giving way over a long period of time. The result is diffuse synovitis, over-redundance of the fat pad, degenerative change in the patella, chondral marginal osteophytes, and the other components of chronic arthritis. Although we may grant that the best treatment would have been prevention and although we may insist that the great majority of these cases can be obviated by good initial management, still this does not help any when we are faced with the patient who already has the problem. The case in Fig. 1 illustrates degenerative changes from chronic damage to the medial meniscus. These same changes may occur as the result of lateral meniscus damage or osteochondritic foreign bodies as well as injury to the medial meniscus.

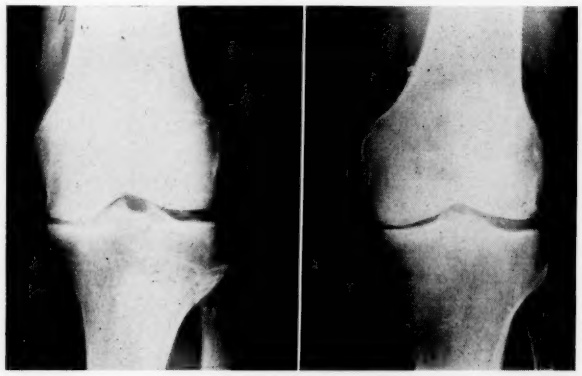


Fig. 1.—*A*, Patient 56 years of age with a history since about age 20 of intrinsic pathological condition in the knee. Note the marginal osteophytes on the medial side with narrow joint space. This is a typical result of long-standing medial meniscus disease. Note calcification of lateral meniscus.

B, Neglected medial meniscus in a knee with a long-standing intrinsic pathological condition. Upon operation the meniscus was found to be badly eroded. There was severe chondral degeneration in both the tibia and the femur and also on the underside of the patella. Although this will never be a normal knee, the patient has been markedly improved by the operation, with relief from pain and diminution of the swelling. Moreover, it is hoped that the progressive degenerative change will be arrested.

There has been a great reluctance on the part of many physicians to undertake definitive treatment of the degenerated knee joint. One is prone to say, "Well, this knee is so bad that it will not respond well to operation" or "You

are beyond the time when you need to be very active so you can get by with what you have." This procrastination simply magnifies the problem. If the patient happens to lead a sedentary life from the standpoint of the knee, he may actually die before the knee completely wears out. However, if he is more active the knee may wear out first.

In my opinion the time to treat intrinsic conditions of the knee is when you first see the patient. If you are fortunate enough to see the patient at age 16 immediately after the injury, this is wonderful, but if you are unfortunate enough not to see the patient until he is 45 years old and already has marked degenerative changes, you should not withhold treatment simply because it will not give an ideal result. A result considerably less than your own ideal may be considered an outstanding result to this patient who has been doomed to disability and pain. He may be very substantially improved in spite of the fact that he still has degenerative changes. He will be grateful for any improvement.

In these chronic conditions it is extremely important to be as specific as possible in your determination of the exact type of injury present and particularly of the entire amount of disability. The patient with a long-standing chronic condition in the knee joint may well develop secondary symptoms which completely overshadow the primary cause. Nothing is more futile than prolonged symptomatic treatment of the knee joint while a specific lesion continues to aggravate the condition. The patella is a particularly vulnerable segment of the knee and is very prone to degenerative changes so that so-called chondromalacia of the patella is one of the most frequent conditions found in the chronically disabled knee. Whatever the cause of such a condition of the patella, one is doomed to disappointment if he continues nonspecific treatment while there is gross injury to the patellar cartilage (Fig. 2). Thus, the patient will be substantially relieved by simple rest in protective splints. His symptoms will inevitably recur when activity is resumed. In such a case it is important to analyze the lesion within the knee with a realistic attitude. One may indeed decide that the condition is not remediable and so elect nonspecific treatment. However, this should be a positive decision based on the circumstances surrounding this particular case. For example, the elderly woman who may cheerfully accept a sedentary life may be instructed in the care of her knee joint so that she can avoid squatting and climbing, reduce her activity to that degree which is consistent with her symptoms, and so live out the remaining years of her life in relative comfort. This patient would not be a good candidate for a patellectomy or chondroplasty of the patellar cartilage for many technical reasons. However, the principle reason for nonoperative treatment is that an operation is not necessary. On the other hand, the younger individual who has led an active life (this is particularly applicable to ex-athletes) may take a very dim view of your advising him to quit squatting, jumping, and running. Such a patient will cheerfully accept the hazards and limitations of an operation if he believes this will have some reasonable chance of restoring some of his erstwhile activity. Unfortunately, most of the cases are not this simple but lie between these two extremes, and it will require keen judgment to determine just what advice to give each patient.

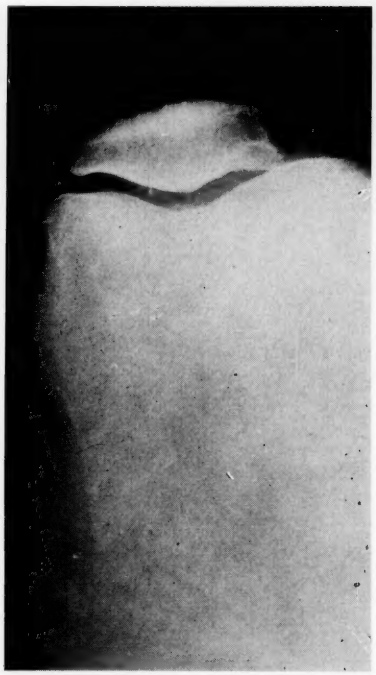


Fig. 2.—Silhouette view of the patella showing severe malacic change on its medial facet. Lateral spurring of patella which is fragmented. At operation this patella was found to be almost completely denuded of cartilage particularly on the medial half. A patellectomy gave marked relief from symptoms and a much more serviceable knee.

The real problem in decision will come in those cases which are borderline, that is, the patient who is neither very young nor very old. He does not intend to be an athlete, nevertheless he does not like to have his activities unduly restricted. His disease may be mild or it may be severe. His occupation may be one demanding excellent function of the knee such as truck driving, or his occupation may be more sedentary such as practicing law. In such a case one must carefully balance his age, the desirable level of activity, the degree of injury in the patella, and the condition of the remainder of the knee and arrive at a decision as to what treatment is proper for this particular patient. In so far as treatment of the patella itself is concerned it may range from good advice to patellectomy. Specifically, nonoperative treatment would consist of:

1. Protection against overuse.
2. Protection against acute trauma.
3. Local treatment of the inflammatory condition in the knee.
   A. Aspiration of the effusion.
   B. Injection with corticoid.
   C. Local heat.
   D. Protection against motion during the acute episode.
4. Systemic treatment.

Systemic treatment is of considerable importance in polyarthritis as the result of a systemic disease. It is of much less value, however, in the treatment of an isolated joint with chronic changes due to old trauma. The measures ordinarily used would be salicylates, cortisone derivatives, muscle relaxants, etc.

If the internist and orthopedist agree that an operation is indicated in any specific case, the orthopedist should be prepared to perform as comprehensive a procedure as is justifiable. Sufficient exposure should be made to permit careful exploration of the entire knee joint so that attention can be given to any disease entity which is found. The patient should be consulted and definite permission should be obtained to carry out whatever procedure seems to be the most acceptable at the time of the operation. It is extremely distressing to operate upon a knee, determine during the procedure that the patella should be removed, and realize that the patient has not been prepared for such an eventuality.

ol. 13
1961

In further discussion of the knee one should mention osteochondritis dissecans. There is some difference of opinion as to the exact pathological condition involved in osteochondritis dissecans. Certainly, it is most common in athletes and there is very good reason to believe it is actually traumatic and so should be considered here. I think many of these injuries are due to abnormal pull on the posterior cruciate ligament attachment. I feel sure that many others are due to direct blows against the cartilage causing subchondral damage. There are many ways to treat osteochondritis dissecans in its initial stages and these need not be elaborated here other than to say if the fragment actually is not displaced and if the patient is young it may be left alone with proper protection.

Whatever the method of early treatment, the thing we are concerned with now is the case we first see as a late result. The case will vary a great deal both as to the location of the lesion and as to its extent, depending upon the original cause of the lesion. The osteochondritic foreign body loose in the joint, the so-called joint mouse, is notorious for causing chronic synovitis, effusion, and thickened synovium (Fig. 3). In fact, this is, the typical picture of nonspecific synovitis. As has been pointed out it would be futile to treat the synovitis and leave the fragment to reinitiate the lesion. The treatment must be surgical. The nature of the operation depends upon the degree of degeneration in the knee. Many of these cases will have very extensive involvement with multiple foreign bodies, marked chondral marginal spurs, and extreme synovitis oftimes appearing as xanthomatous or villonodular involvement (Fig. 4). Some of the symptoms may be relieved by the time-honored practice of getting the patient off his feet but this is at best an inadequate method for definitive treatment. The main point of discussion must arise concerning the extent of surgical intervention. Here, as we have pointed out previously in regard to the knee, one's decision as to the extent of the operation should depend upon his judgment as to what would give the best function. If a person is elderly and the main object of the operation is to prevent the knee from catching and so causing him to fall, one might be satisfied simply to remove the foreign body with the least trauma possible. In the younger, more active individual this will be very unsatisfactory because the patient is not particularly pleased with elimination of his catching but continuation of the rest of his symptoms—swelling, pain, and disability.

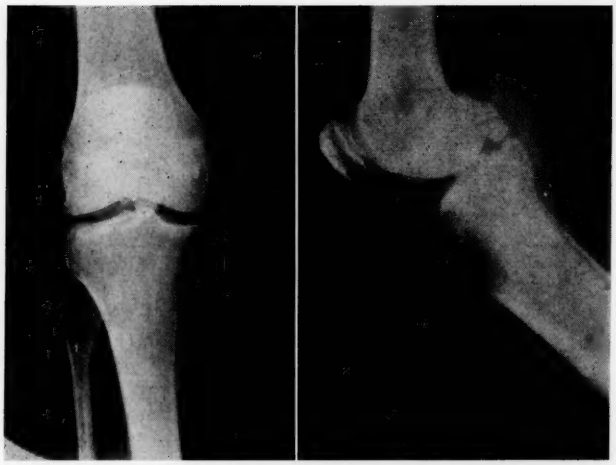


Fig. 3.—Single osteochondritic foreign body, the result of an osteochondritis dissecans of the medial femoral condyle. Repeated episodes of locking followed by synovitis had caused considerable degenerative change particularly under the patella. The patient was improved by removal of the foreign body and chondroplasty of the patella.

A, Preoperative anteroposterior view.

B, Preoperative lateral view.

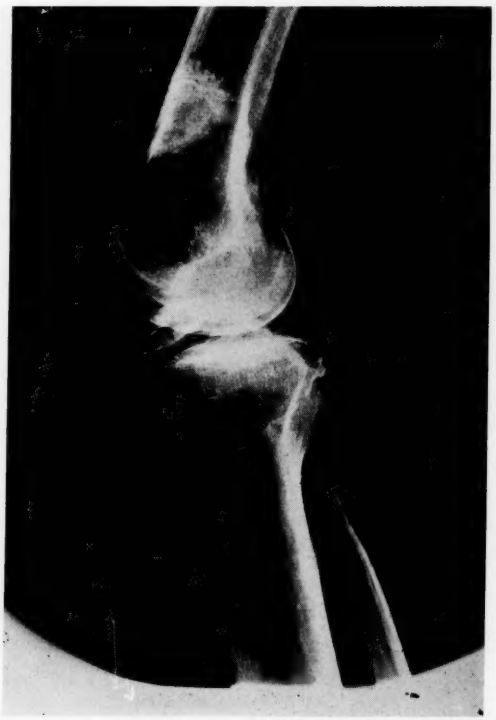


Fig. 4.—An unusual example of extremely large osteochondritic foreign bodies resulting from osteochondritis dissecans. Although treatment was long overdue on this patient he got substantial relief by removal of the foreign bodies and a general cleaning up of the joint particularly the marginal osteophytes, the malacic patella, and the redundant fat pad. Marked improvement followed surgical treatment.

I do not believe one is justified in subjecting his patient to a life of inactivity simply because a normal knee joint cannot be expected following an operation. Some of our most gratified patients are those who conclude their treatment with a knee which is far from normal. The fact remains that it is so much better than it was before that to this particular patient the treatment has been a godsend.

The most distressing sequelae of athletic injuries in the knee are the residual of ligament injuries, the so-called unstable knee. This presents a very serious problem. The two major categories of ligament injuries which cause late symptoms are injuries to the collateral ligaments and injury to the cruciate ligaments. The problem one ordinarily encounters is that of a middle-aged adult who is having increasing trouble in the knee. He describes his knee as being "wobbly" and insecure, with gradually increasing disability. These cases are the result of sprains of the knee in which the healing has been incomplete. In the collateral ligaments it usually means that the ligament has healed but is too long. In the cruciate ligament it most frequently means the cruciate has been torn and absorbed. One can have a surprisingly good degree of function in the knee with a redundant collateral or cruciate ligament so long as he maintains good muscle tone, good joint cartilage, and normal menisci. He has long since learned the level of his activity. He has given up hand ball, tennis, and golf. Indeed he has given up sports altogether and has learned to protect his knee in situations that are likely to cause him trouble. As aging advances, however, the remaining ligaments become less elastic, the cartilage in the knee becomes less resilient, the menisci become sclerotic, chondral marginal osteophytes appear, and he has the classic picture of chronic arthritis of the knee. This differs from the arthritis previously described in that there is the additional factor of instability. That is, the basic problem instead of being malacia of the patella or damage to the meniscus is, in this instance, instability. The problem is magnified by the fact that the very sequelae of instability cause increase of the relaxation in the joint, namely, the joint cartilage thins, the menisci narrow and flatten, and the marginal osteophytes become larger and so irritate the remaining ligament and a vicious circle is instituted (Fig. 5).

Specific treatment here presents a very serious problem. This problem is not materially lessened if the surgeon operates and does a "house cleaning" of the joint. This simply relieves the secondary symptoms of sclerotic menisci and exostoses. Indeed, it may make the condition worse since it may add to the very instability which is the cause of the trouble. It is difficult here to recommend elimination of the basic lesion. Often one finds himself faced with a collection of "undesirables," not referring to the patient but referring to the types of treatment available. It is undesirable to the surgeon to reconstruct the ligaments. The alternative of wearing a brace is not acceptable to the patient nor does he cheerfully accept your recommendation that he quit using his knee. In some instances this might mean that he would starve or go on welfare. The final recourse of a fusion of the joint is bitterly resisted also. In the younger group of active individuals with disabling instability I think one is justified in reconstructive operations particularly to the collateral ligaments. In the middle-aged group I have many times been gratified to obtain a satisfactory result following

plication of the medial collateral ligament. I have at other times been very distressed with a poor result from this procedure. In the elderly I can see little justification for extensive reconstructive procedures.

A. *B.*

Fig. 5.—This is an example of a knee with chronic instability, the result of long-standing anterior cruciate and collateral ligament instability.

A, The involved side shows the narrow joint space, irregular chondral margins, and the beginning of chondral marginal spurs which will result in a typical degenerative knee.

B, The normal side for comparison.

Some word should be said about the patient who presents himself with primary synovitis of the knee. Typically this case does not have other intrinsic complications. There should be no symptoms of meniscus damage. The patella should be relatively normal, the ligaments intact, the primary symptom being distressing and recurring effusion. This patient usually comes to the doctor because of swelling in the knee. The knee is often quite asymptomatic except for the swelling. This condition may progress until the synovium is thickened, palpable, and painful. There may be recurring episodes of local heat and signs of inflammation. Here one must determine in the individual joint whether or not this is a sequela of chronic irritation of the synovium, or is indeed a true infectious type of arthritis. One should seek very diligently for extrinsic causes of this trouble. General examination is of great importance: temperature, pulse, general physical examination; laboratory procedures such as urinalysis, differential blood count, sedimentation rate, are all of great importance since they should all be negative in localized traumatic synovitis of the knee. Local treatment is of considerable importance in these cases. It should consist of aspiration of the effusion, compression bandage, some degree of immobilization (depending upon the degree of symptoms), injection of corticoids, and local heat. Many cases will respond to this type of therapy in a very gratifying way. A certain number of cases will not respond to any type of local treatment. One is faced with the question as to whether or not an arthrotomy of the knee is justified. This is the type of case in which a primary synovectomy is done. Unless the specific lesion is found and eliminated the result is likely to be unsatisfactory.

One might conclude from the above that my suggestion for a remedy for chronic conditions of the knee is uniformly by surgical means. This is far from true. Many knee conditions will respond well to local nonsurgical measures. I have pointed out, however, that if there is a definite lesion existing which in itself tends to aggravate the degenerative change in the knee, one is not justified in withholding an operation simply because an ideal result may not be obtained. If one can do no more than stop the progression of the degenerative change, an operation may be justified. If this is necessary, the earlier it is done the less extensive it will have to be. To illustrate: If the ruptured medial meniscus is going to lead ultimately to degenerative changes in the knee with malacia of the patella, chondral marginal osteophytes, diffuse synovitis, and recurring effusion, this progressive change could be prevented by early primary removal of the meniscus. It is equally true that removal of the miniscus should be recommended at whatever time the diagnosis is made that the damaged meniscus is the cause of the changes in the knee. If this diagnosis is not made until the patient is 45 years of age, or if the patient has refused operation until such a date, the best one can do is operate at that time even though he well knows it should have been done long before. Surprisingly good results may be obtained if the degenerative change has not been too extensive.

ANKLE

While injury to the ankle joint is the most frequent injury to the athlete, it is much less likely to have sequelae than is injury to the knee. Anatomically the ankle is an extremely stable joint with the talus well mortised into the two malleoli. The injuries to which it is subject are much more likely to heal spontaneously than those of the knee. It is also possible to protect the ankle very adequately by strapping and wrapping so that further injury can be prevented. There are nevertheless many situations where chronic residual disability occurs. The most common residual disability is the so-called chronic or recurrent sprain. This occurs in the ankle which has been subjected to repeated injury with resultant redundancy of the lateral collateral ligaments and lateral instability in the ankle mortise. Each time the ankle is sprained the talus tends to sublux from the fibula and irritative changes may occur. These are usually manifested by chronic synovitis of the joint with swelling, chronic pain, and instability. Treatment of such a condition is ordinarily not surgical in nature. The ankle being inherently stable can usually be supported by a properly fitting shoe, with a lateral wedge on the sole tending to throw the weight more toward the medial side. The patient should be advised not to attempt to wear high heels since this increases the instability by plantar flexion of the foot. In this position the narrow part of the talus lies in the ankle mortise and the relaxed ligaments become even more redundant. If this condition is encountered in a younger individual, lateral ligament reconstruction may be done. Whether or not surgical treatment is recommended would depend upon the decision in this particular case in regard to the degree of disability, its correctibility by nonsurgical measures, and the probability of success of the surgical procedure (Fig. 6).

Local measures for the acute attack should be strapping of the ankle with a Gibney type dressing designed to prevent inversion of the foot. This may be preceded by local injection of a corticoid into the joint if synovitis is present.

A. *B.*

Fig. 6.—Chronic unstable ankle.
A, Normal side.
B, Stress x-ray illustrating the redundancy of the lateral collateral ligament, a long-standing condition following injury. Note the spurring around the medial malleolus, the irregularity of the medial edge of the talus with spurring and calcification around both fibula and lateral talus. There is marked degenerative change in this ankle.

Another condition of the ankle joint which is to some degree peculiar to the athlete is talotibial exostoses. In this condition as a result of repeated forcible dorsiflexion of the foot on the leg, osteophytes pile up along the leading edge of the tibia, along the front of the medial and lateral malleolus, and in the corresponding opposing areas of the tarsus, particularly the neck of the talus, the lateral surface of the calcaneus, etc. These conditions may be well tolerated in younger life. As the patient becomes older and the spurs become larger, chronic degenerative changes in the joint occur and secondary traumatic arthritis ensues. The condition primarily did not involve the joint cartilage but secondary involvement of the articular surface follows. If possible these spurs should be removed before the degenerative joint changes occur. Unfortunately, the patient frequently is not seen until the picture of chronic degeneration is already present (Fig. 7).

Calcium deposits may come from other conditions about the ankle joint as well, a frequent one being tearing of the tibiofibular ligament with some separation of the ankle mortise. This leads to the deposit of calcium along the interosseous membrane between the tibia and fibula, and in the distal tibiofibular ligaments. The irritation due to the instability of the joint will cause chronic degenerative changes between the talus and fibula (Fig. 8). In such a case recognized early the calcium should be removed and the stability of the ankle mortise re-established. A normal ankle may result whereas if the condition is allowed to continue it may go on to extensive degenerative changes (Fig. 9).

Another insidious condition about the ankle is osteochondritis dissecans. This ordinarily involves the talus and is readily overlooked (Fig. 10). This condition in the acute stage, has been a cause of much futile treatment. The chronic

Fig. 7.—An example of talotibial exostoses.

Extensive talotibial spurring in a baseball player. Note the narrowing of joint space between talus and tibia and the evidences throughout the foot of some degenerative change. These spurs should have been removed several years ago.

Fig. 8.—A case illustrating tearing of the tibiofibular ligament with deposit of calcium in the interosseous membrane and separation between the tibia and fibula. This will inevitably proceed to chronic disability and degenerative change in the ankle. This is prevented by excision of the calcium and restoration of the joint mortise.

change is the result of chronic arthritis of the joint with breaking down and narrowing of the articular cartilage. This is particularly likely if the cartilaginous fragment from the superior portion of the talus is actually loose in the ankle. Here again the best treatment is prompt management of the original injury before chronic changes occur. If the condition involves the superior portion of the talus it may require ankle fusion for relief.

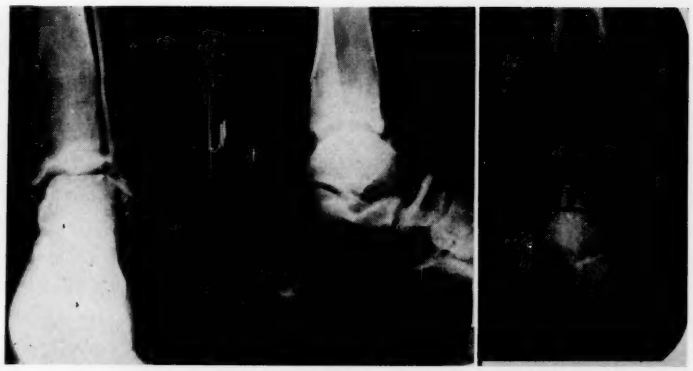
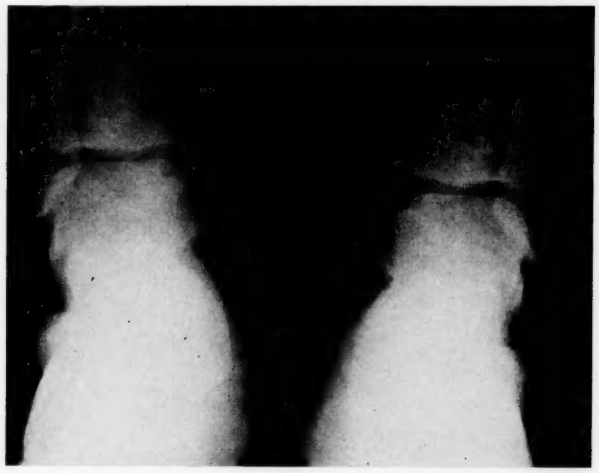


Fig. 9.—Case similar to that shown in Fig. 8. Instability of the ankle mortise has resulted in gross changes between the fibula and talus. Note that the lateral view reveals neglected talotibial exostoses with resultant degenerative change.



A. *B.*

Fig. 10.—Bilateral so-called "osteochondritis dissecans" of the talus.

A, The right foot showing a large fragment separated from the talus at its medial superior angle. This fragment was about 1¼ inch long, ½ inch thick, and ¾ inch wide. It was entirely separated from the talus leaving a large defect. This is probably a chondral fracture, and in this patient it would have been much better to have removed the fragment months before.

B, Similar involvement of the left foot with less severity. The history is of "sprains" of the ankle with increasing disability.

Many of the cases of so-called idiopathic synovitis of the ankle are indeed due to chondral fracture or osteochondritis dissecans which is not recognized because of inadequate x-ray study. In the chronic case I think one is justified in advising removal of the fragment before resorting to ankle fusion, since this procedure combined with general "cleaning up" of the ankle may permit a tolerable degree of activity and the ankle fusion may be avoided or at least postponed.

UPPER EXTREMITIES

The upper extremities are not subject to the same stresses as the lower because the element of weight bearing is eliminated. However, there are chronic

conditions which result in the upper extremities because of athletic competition. This is particularly notable in the baseball pitcher who puts strain upon the shoulder, the elbow, and even the wrist in some of the unusual deliveries. Usually these conditions improve spontaneously because the termination of forceful throwing will alleviate the symptoms to a considerable degree.

There are many injuries to the wrist in the course of athletic activities. Most of these in young individuals are amenable to correction and result in no chronic disability. The most common cause of chronic disability of the wrist in the athlete is a fracture of the navicular. This insidious fracture is very frequently overlooked. The history usually is that of repeated sprains, each one of which does not quite recover. At some time in this sequence, careful x-ray study is carried out and the fracture is revealed. If this is late in the course of events nonunion is already well established and a very careful evaluation will need to be made to determine the best treatment. The case we are primarily concerned with here is the one which goes on for many years with or without early recognition, the treatment having been postponed because of the fact that the degree of disability present was acceptable to the patient. As age advances and the carpal joints narrow, the symptoms of chronic arthritis may become more severe (Fig. 11). These may be controlled by diminution of activity, protective support, and local treatment. If they cannot be, some definitive treatment must

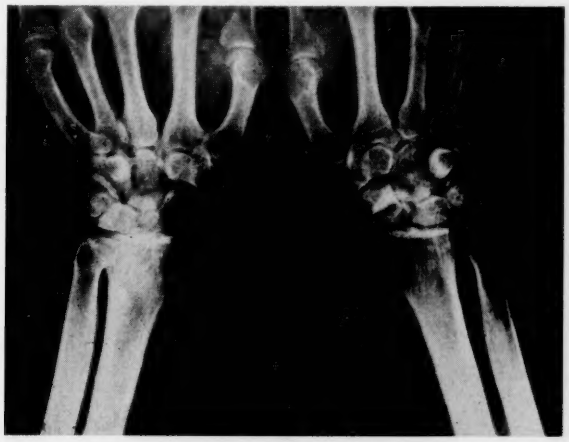


Fig. 11.—Long-standing nonunion of the carpal navicular fracture following a football injury. Patient is now 60 years of age with advanced degenerative arthritis of the radial carpal joint and sclerosis of the adjacent margins of the fragments.

be undertaken. The patient with a fractured navicular with chronic changes in the radial carpal joint and atrophy or sclerosis of the navicular fragments, poses a severe problem for the orthopedist. An operation should be undertaken only if the exigencies of the local situation demand some remedy. Far more commonly the decision regarding the necessity for an operation will arise earlier in the course of the injury (Fig. 12). At that time there are various procedures possible which will not be detailed here. This fracture heals well if treated promptly and adequately. Usually an operation is not necessary. Here again the plea must be for

early recognition of the injury. Careful clinical examination of the original injury will usually give the clue because tenderness is localized in the navicular. However, any case of sprain of the wrist which is severe enough to justify x-ray examination at all demands oblique views. These will ordinarily reveal the fracture quite distinctly. The chronic case which is not suitable for an operation may often be relieved by a leather wristlet to prevent extremes of motion. Sometimes simple excision of the radial quarter of the lower end of the radius will eliminate a good deal of the pain which is due to impingement between the radial styloid and the irregular navicular.

Fig. 12.—Typical fractured navicular of many months' duration (so-called chronic sprain). This young individual was treated by bone graft and obtained good union. Other possible methods to consider would be screw fixation or removal of the proximal fragment.

We occasionally see severe changes as the result of persistent overuse of an injured joint. This is illustrated particularly at the elbow where the lesion may start as a mild degree of calcification of the capsule of the joint and proceed to extensive changes with multiple cartilaginous foreign bodies and degenerative arthritis. From the standpoint of treatment it is much simpler to limit the activity of the upper extremity than that of the lower. In the great majority of cases nonsurgical treatment is quite effective. The occasional case may be so extensive as to require surgical treatment, particularly if the demands of activity of the individual are rather severe. Fig. 13 illustrates the case of a baseball pitcher who is now a coach. The extensive calcification of the capsule and foreign bodies in the joint precluded any attempt at pitching. This became so severe that he could not even throw the ball in demonstration of ordinary positions to his trainees. It became quite important to him to have a better degree of pain-free motion in his elbow. This was felt to be sufficient justification for an operation and the foreign bodies were removed. This has resulted in sufficient

improvement that the patient is continuing his coaching activities and is well satisfied. A patient in a sedentary occupation might well accept the degree of limitation in preference to the operation, particularly since the operation could not offer any promise of a normally functioning elbow. This case represents the extreme of this condition. By far the great majority of such patients will present spurring, small cartilaginous fragments, and much less over-all disability. If the patient is relatively young and has considerable disability, an operation would be indicated. If not, proper instruction of the patient by the physician will result in satisfactory solution of the problem.

Fig. 13.—Extensive calcification following chronic sprain in the baseball pitcher referred to in the text. This was improved by surgical excision.

This calcification is also present to some extent at the shoulder and is extremely distressing during the active part of the player's career. It has been unusual in my experience to see chronic changes in the shoulder of an older person, as a result of athletics, which were sufficiently magnified to justify anything other than the ordinary measures of local treatment, such as heat, massage, and restriction of activities. These calcifications about the shoulder are usually the result of strain on the ligaments and capsule or the muscle attachments and do not represent fractures.

Another condition about the glenohumeral joint is chronic recurrent dislocation of the shoulder which may be either anterior or posterior. Many of these shoulders become so relaxed that they are dislocated even in ordinary activities. Such a patient is entitled to the benefit of surgical treatment with tightening

up of the ligaments about the shoulder to the extent that stability is obtained even if it implies some restriction of motion. The neglected recurrent dislocation often leads to chronic degenerative change in the joint. These are not really as consequential as those involving weight-bearing joints. However, posterior dislocation of the shoulder may be unrecognized for many years and result in serious disability of the shoulder (Fig. 14). Careful analysis of the original injury will usually reveal an unreduced posterior dislocation. Late treatment of this condition is quite unsatisfactory although the joint may be improved by an operation. Here again, prevention is very much more effective than cure.

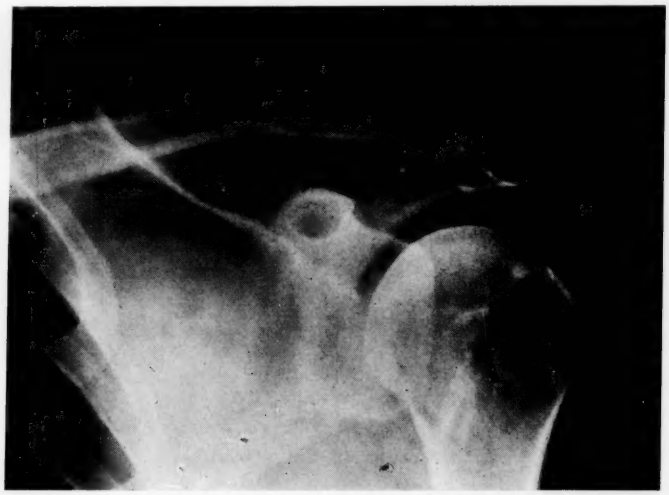


Fig. 14.—Unrecognized posterior dislocation of the shoulder resulting in chronic changes, with restriction of motion and pain.

One of the most common chronic conditions about the shoulder involves the acromioclavicular joint (Fig. 15). This joint is particularly subject to chronic irritation with calcification of the capsule, erosion of the joint cartilage, and destruction of the intra-articular fibrocartilage. This is the typical picture of chronic degenerative arthritis. Many patients have learned to live with this disability. However, it is relatively simple to relieve by surgical excision of the outer end of the clavicle which in effect eliminates direct apposition in this joint. This resection actually needs to include only the distal ½ inch of the clavicle although a wider excision may be carried out if desired. This is a classic example where careful definition of the cause of the lesion will permit relief of the symptoms. One should not withhold surgical correction where it is relatively simple and highly successful.

SUMMARY

There are many other injuries to which the athlete is prone which may result in chronic changes. Detailed discussion of these is beyond the scope of this article.

The most frequent ones have been discussed. Such conditions as chronic cervical spondylitis, various conditions about the hip joint, changes in the fingers, and static conditions of the foot may conceivably have been initiated by some past injury. This is the exception and not the rule, however, and there is usually no specific connection between the past injury and the present disability.

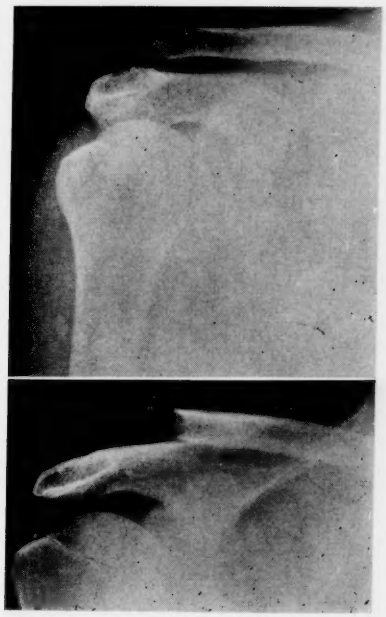


Fig. 15.—Neglected subluxation of the acromioclavicular joint resulting in calcification of the capsule, degeneration of the articular cartilage, and pain. The condition was relieved by resection of the outer end of the clavicle distal to the coracoclavicular ligaments. Resection is more extensive in this case than is necessary.

In recapitulation of the principles above described I would like to emphasize a few points which are applicable to any of these chronic conditions. In the first place, a very careful evaluation of the condition should be made to determine, if possible, the initiating cause of the present condition. While the initiating cause may not be the most outstanding factor in the present disability, one may by determining the initial cause be able to follow the sequence of events and so be much more intelligent in his recommendation to the patient. Such historical evaluation should be followed by a careful definitive consideration of the present condition. Particular emphasis should be placed on the disabling element in the present condition since disappointment will result from the treatment of obvious lesions if the underlying cause is still present. After such extensive evaluation, the decision for treatment must rest upon the careful balancing of all the factors concerned. In this consideration, the vital questions to be answered are: (1) Is the disability such that it interferes materially with the required level of activity of this particular patient? (2) Is the disease process such

that it can be remedied by reasonable measures? (3) Is the patient's entire circumstance such that he can well tolerate the treatment required? If the combination of these answers shows a patient who can tolerate the treatment for a condition which interferes with his activity and is remediable, the answer is obvious: treatment should be carried out. Lacking any one of these factors treatment probably should not be surgical. A comprehensive evaluation of the patient with chronic disability of a single joint will be extremely rewarding in the majority of instances.

Vol.
196

REHABILITATION OF THE CHRONICALLY DISABLED

ROBERT MAZET, JR., M.D., AND JACQUELINE PERRY, M.D.

LOS ANGELES AND DOWNEY, CALIF.

From the Orthopaedic Service, Wadsworth Hospital, Veterans Administration Center, the University of California Medical Center, and the Rancho Los Amigos

(Received for publication Nov. 1, 1959)

TRADITIONALLY, medicine is directed toward saving of life and prevention and cure of disease. There are today a formidable number of patients with chronic disabilities who are in general good health, because our ability to save life has outstripped our ability to cure. Unless the disability is minor, the average patient is unable by himself to adapt his habits sufficiently to resume his place at home and on the job without the benefit of rehabilitative service. As a result, special techniques and treatment centers have evolved to provide the necessary assistance. Rehabilitation is a program designed to re-establish the patient as an active, contributing member of society despite major residual disability from a chronic disease or injury, be it static or slowly progressive.

For purposes of diagnosis, prognosis, and curative therapy, medical care is primarily focused upon the site of involvement, but the patient's level of activity is determined by the function in the uninvolved areas. *What is left* is the area with which rehabilitation is primarily concerned. Efforts are directed to improving, as well as maintaining, function in the uninvolved areas if this is possible.

A workable system for the treatment of the chronically disabled has evolved from the experience in specialized disease and rehabilitation centers. The first well-organized, long-term efforts in this field resulted in the establishment of special hospitals, such as the Hospital for Special Surgery in New York, to treat congenital deformities, tuberculosis, chronic osteomyelitis, and poliomyelitis. These were followed by facilities in the Armed Forces designed for the treatment of amputees, hand injuries, and spinal cord injuries. Numerous civic agencies now support centers dedicated to restoring patients with chronic maladies to useful lives. In them, the patients are analyzed, inspired, cajoled, heated, massaged, exercised, operated on, braced, trained, and re-educated to become contributors to, rather than a burden on, society.

Experience in these specialized centers demonstrated the similarity of the functional needs and modes of treatment of patients whose medical problems are widely divergent. A careful evaluation of the patient's abilities, needs, and desires can determine the appropriate program of physical and vocational restoration indicated in each case. The diagnosis may be of value for prognosis.

It can indicate the general direction of the therapy to be followed, but not the specific restorative measures to be used for the individual.

The cardiac muscle has an elasticity and a reserve. Prescription for the patient with myocardial damage depends on how much of this is retained. The spastic paralyses from trauma, vascular accident, infantile cerebral palsy, chorea, etc., present problems of hyperstimulation with spasticity of muscles of the extremities of varying degrees of severity, depending on the site and extent of the lesion. The flaccid paralyses, such as poliomyelitis, syringomyelitis, and spinal cord and peripheral nerve injuries, present problems consequent to loss of the normal motor impulses with resulting loss of muscle power and with joint instabilities. The extent of the disability depends on the functional impairment and level of the lesion—not the diagnosis attached to the disease which produced it. Respiratory embarrassment may result from the frozen costal joints caused by rheumatic arthritis as well as from paralyses of respiratory muscles. Soft tissue contractures about joints, from many different causes, may produce deformity and lessening of function. Physical therapy is the same regardless of cause.

When analyzing the problem presented by cord injury in the neck, for instance, it is more meaningful to delineate the function remaining than to designate the disability as a lesion of a specific vertebral level. A patient with a fracture-dislocation of C5-6 may or may not have retained full deltoid function, elbow flexion, forearm rotation, and wrist extension. A diagnosis is, of course, necessary for record purposes and sometimes in the interests of public health. It may also be of value prognostically.

Both the evaluation and the treatment program are best accomplished by a team of experts from many fields. These constitute our "rehabilitation team." Such a group, meeting regularly to consider problems and ideas, can accomplish far more than the same persons could acting individually. The team members are the patient with his relatives, the doctor, nurse, physical or occupational therapist, brace or limb maker, psychiatrist, social worker, teacher, vocational counselor, and engineer. Other consultants are included when indicated (i.e., plastic surgeon, cardiologist, etc.) (Fig. 1). The complexity of the problem, of course, determines the extent of participation of the various members, but each member should have the opportunity to evaluate the patient early in his program. The combined knowledge, artistry, and skill of many disciplines are required to bring about the transformation we seek in the patient.

The idealism of such a group must be tempered by recognition of the limitations imposed by the physical and mental realities. The extent of the disability, prognosis for return of function, and motivation of the patient toward independence and self-support will dictate the course of treatment.

For the individual patient then, we must select an attainable goal. He should be guided, not toward the Everest of unimpaired function when this is obviously beyond his capacity, but toward a lower peak which he can climb and, in this accomplishment, find reward. An overly ambitious, unrealistic program will lead to discouragement and lessen the patient's capabilities, conceivably to result in at least partial failure. Part of the successful program is to educate the patient to establish or reach for realistic goals. He must not be permitted to

become discouraged when the goals hoped for are not achieved, but should be directed and in every way helped toward realistic goals. In each case there must be frequent review of the problems of restoring the patient as nearly as possible to normal. New techniques and devices to help do this must be constantly and avidly sought. The goal is not to make the paraplegic independent in the activities of daily living or the bilateral amputee ambulatory without crutches. These individuals must be motivated to self-support as well as to self-care.

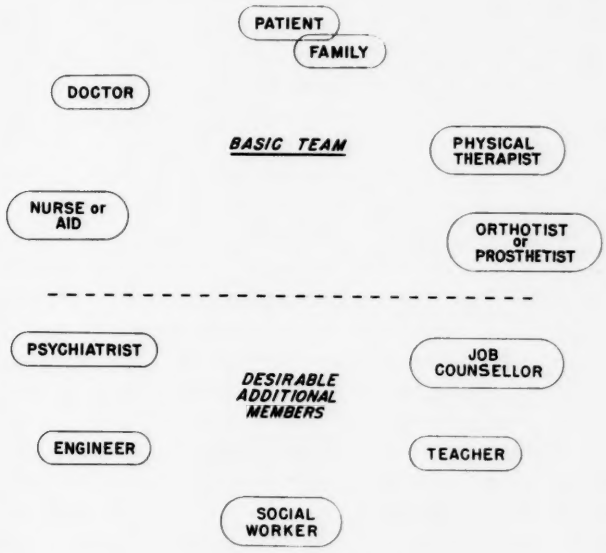


Fig. 1.—The rehabilitation team.

DIRECTING THE PATIENT TOWARD RE-EMPLOYMENT

It is obviously advantageous to commence directing the thinking and activities of the patient toward productivity as early as possible. The family can be helpful here by always presenting an attitude of assurance that the patient will return to outside activity, but they should not appear to be pushing him into any situation before he is ready. In most instances, the patient thinks and works initially toward improved function. Undoubtedly, there is some subconscious thought of work. Undirected, he is ordinarily not ready to plan seriously for outside existence and an occupation until he feels that he has regained the maximum function that can be anticipated. In a carefully directed physical restoration program, however, the patient will learn to differentiate between maximal physical recovery and learned functions which he has achieved. With such a realistic interpretation of his problem, vocational planning can be started during the later stages of his functional training program and considerable time saved.

The steps which must be taken to achieve restoration of the patient as rapidly and completely as possible are:

1. Prevention of aggravating factors such as
   a. Deformities
   b. Decubiti
   c. Kidney complications
   d. Respiratory complications
2. Minimization as much as possible of the emotional impact of the illness (keep home contacts)
3. Physical restoration
   a. Muscle training
   b. Surgical reconstruction
4. Emotional readjustment, including reorientation as to employment capabilities
5. Job training
6. Transitional employment
7. Re-employment (or employment)

Specific programs for the treatment of various types of chronic disabling diseases have been delineated in a voluminous library of books and articles. The general subject is well covered by the text of Rusk[20] and in an article by Redkey.[16] Some of the problems peculiar to arthritis are discussed in articles by Herford and Nickerson,[4] Law,[7] and Lowman.[9] Cardiac rehabilitation is considered by White and coauthors[23] and Sobin and associates.[22] Paraplegic problems are dealt with by Comar[3] and Nyquist.[15] Some of the epileptic problems are expounded by Risch and Rose.[17] Certain aspects, including treatment, of poliomyelitis are reviewed by Lowman[8] and by Nickel and colleagues.[14]

Selective placement of the handicapped individual has a literature of its own. Helpful suggestions are made in articles by the following: Irvin,[6] Melcher,[12] Risch,[18] and Rudd and Feingold.[19] Two brochures are also valuable: "Impaired, Employed, Insured" by the Association of Casualty and Surety Carriers[5] and "Selective Placement for the Handicapped" by the U. S. Employment Service.[21] This list is in no sense complete.

Overtreatment is an ever present danger. Patients do need moral support from the members of the rehabilitation team. Sometimes the families need psychiatric, social, or other assistance as well. However, the patients should be constantly stimulated to realize a goal of self-support as well as self-care. Where this is attainable, they can benefit from, and learn by, association with other handicapped patients. By the same token, a ward atmosphere of complacency and contentment to make the hospital a home has to be guarded against constantly. An attitude of overprotection and too much sympathy can militate against the patient's desire to live outside, which we wish to foster. Hospitalitis is a virulent but largely preventable disease.

Orthopedic surgery can often make valuable contributions to patient care. Below are case reports which illustrate four specific orthopedic operations which were helpful in the restoration of 4 patients. These by no means exhaust the

selection of orthopedic operations which can be done. They display a few of the possibilities available.

Case 1, J. B.—A 33-year-old man had been discharged from the Navy because of rheumatoid spondylitis. He was forced first to change his occupation from machinist to parking lot attendant. After 2 years, a gradually increasing flexion deformity of the spine and increased pain made any work impossible and led him to seek help. He had marked muscle spasm and aching of the upper thoracic spine and neck after a couple of hours on his feet. His vision was restricted; he could not see straight ahead.

In August, 1948, vertebral osteotomy at L2-3 and L3-4 levels was done, with considerable improvement in posture (Fig. 2). This resulted in bringing the shoulders and head back over the hips, relieved the strain on the upper spine, and enabled him to see well above the horizontal. He gained 25 pounds and went back to work promptly. He is a well-motivated person who wants to support his family. He has had recurrent episodes of renal calculi, and the left hip has given him trouble several times. It is wearing out, and we hope for a spontaneous fusion.

A. *B.*

Fig. 2.—Case 1, J.B. *A*, Before operation. *B*, Improvement in posture and increased range of vision after spinal osteotomy.

In addition to his employment at a parking lot, he has recently been working half time making wooden crates in the shipping department of a manufacturing concern. Supportive therapy by the arthritis clinic and the urologists, with intermittent ministrations by physical medicine, have helped this well-adjusted man to maintain a good employment record, after the operation permitted him to stand up straight on his two feet. Eleven years after the operation, he is working regularly.

Case 2, R. G.—An explosion in his home laboratory blew off both forearms of a 15-year-old boy. He had a 5-inch stump on the right, a 5½-inch stump on the left.

He was fitted with an experimental active forearm rotation unit (R), wrist flexion units (B), and interchangeable Northrop 2-load hooks and APRL hands.

This boy and his family made an immediate excellent adjustment to his problem. He learned to use his devices quickly and readily with relatively little training. He resumed his place in school and home. His family encouraged him in photography and set up a dark room in his home. He

asked for an adapter to permit pistol shooting. This was made and he has become an expert pistol shot (Fig. 3). He has helped in evaluation of the efficacy of several prosthetic devices. Five years after the accident, he has finished high school and is employed full time as a sales representative for a photographers' shop. He does the mechanical work on his car.

A well-motivated boy, with understanding and sympathetic support from his family and prescription, training, and encouragement from the prosthetic team, has met and conquered a very severe handicap.

Fig. 3.—Case 2, R.G. Patient at target practice with pistol-holding device.

Case 3, A. Y.—This 37-year-old laboratory technician contracted poliomyelitis 7 years ago, which necessitated a tracheostomy and a respirator for 6 months. As a result, he had complete paralysis of both shoulders, his trunk, and both lower extremities and considerable weakness of his diaphragm and both hands. In order to sit up at all, he needed a heavily reinforced corset for both trunk stability and abdominal support for effective breathing (Fig. 4,*A*). A spine fusion from T3 to L3 and abdominal fascial transplants[8] have enabled him to sit erect all day without fatigue (Fig. 4,*B*), and bilateral tendon transfer for his thumb has improved his hand function. He is now employed as a cancer cytology technician.

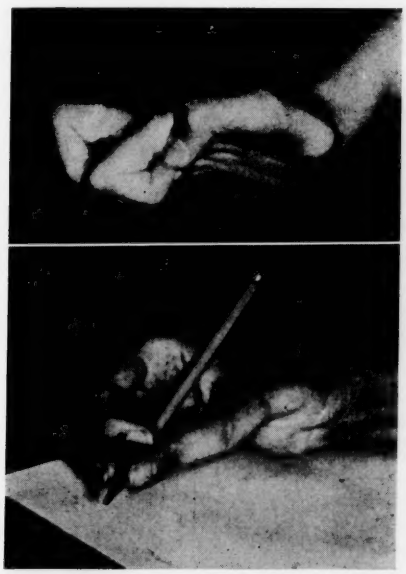
Case 4, C. D.—This 28-year-old, single reservations clerk contracted poliomyelitis 4 years ago, with severe paralysis of both upper extremities and diaphragm. She required part-time respiratory assistance for over 1 year and continues to need it during postoperative periods. Her residual involvement consisted of complete paralysis of the left arm, except for poor elbow flexion and good finger extension. The right arm has good shoulder, elbow, and wrist function, but poor hand function (Fig. 5,*A*). Much of this strength developed after prolonged use of functional arm and hand braces. Operation on the hand has improved her function and allowed her to be free of a brace. The thumb and first two fingers were stabilized in a position of function by phalangeal fusions and a opponens bone block.[13] Transfer of a wrist extensor muscle to her finger flexor gave a strong grasp. As a result of a similar operation, she has a useful light grasp on the left. The operations and a happy marriage have combined to produce a completely independent housewife, who does her own housework (Fig. 5,*B*).

The weak link in the chain of total rehabilitation is in the transition from the closely supervised physical restoration program described previously to

A. B.

Fig. 4 —Case 3, A.Y. *A*, Preoperatively, the patient could not sit without support. *B*, After spine fusion and fascial abdominal transplants, he sits easily and for as long as he wishes.

A.



B.

Fig. 5.—Case 4, C.D. *A*, The preoperative view shows a deformed, paralyzed hand with practically no useful function. *B*, The postoperative view shows pinch (8 pounds) and useful grasp.

independent living and employment. The initial step of adapting the home and the patient's mode of operation to permit independent self-care is usually part of the rehabilitation program, but the subsequent steps which lead to successful re-employment are frequently haphazard.

This is basically due to the difficulties of integrating two fields with such dissimilar purposes as medical care and business. Superimposed upon this lack of coordination is the reluctance of employers to hire the handicapped. This stems from both real and imaginary factors which can be classified as follows:

1. Inertia
2. Prejudice
3. Necessity for costly outlay in plant modifications
4. Fear of potential increase in insurance premiums for handicapped employees
5. Fear of trouble with unions
6. Inadequate coordination between job counselor and hiring personnel

Inertia.—Most organizations are accustomed to operating only with employees who are not physically handicapped. They have no wish to experiment with handicapped people.

Prejudice.—The physically handicapped person is less agile and not as quick. He is unable to perform some tasks and is less able to jump out of danger if something goes amiss, and he is also less adaptable when it becomes necessary to shift him from one job to another. Association with epileptics and spastics is distressful to some workers.

Increased Insurance Premiums.—Insurance rates are based on the type of work being done and the accident experience of that company. There is no increased premium for handicapped employees per se. Experience to date has shown that disabled people have a lower accident rate than their normal co-workers. In many states there is a special fund to compensate the employee, without penalizing the employer, in the event of a second injury. If a partially disabled employee, as the result of a second injury, becomes 70 per cent or more disabled, the employer pays the difference between the initial and second disability. The state pays the remainder.

Unions.—The unions offer no specific objections to the hiring of handicapped persons. In fact, they support the employment of such people. Difficulties do arise in placing a worker in a different job following injury because of seniority rules insisted on by the unions. Seniority earned by service in one field does not carry over into another kind of work.

Coordination Between Job Counselor and Hiring Personnel.—A handicapped employee is of value only when the use of his skills is not obstructed by his disability. Successful placement is therefore dependent upon the understanding of the job requirements as much as the evaluation of the individual's capacity. This can only come about when there is adequate cooperation between placement and counseling personnel.

The transitional, or sheltered, workshop can assist in eliminating some of the obstructive factors. It acquaints the medical team with the problems of the business world so they can plan more realistically. The patient is given the

opportunity to develop efficiency in his trade (including use of any necessary adaptive devices), endurance for a full workday, and skills to cope with his altered situation. The prospective employers can see the successful productivity of the disabled person.

Several communities throughout the nation have sheltered workshops devoted to a program of transitional employment. However, there is no uniformity of aim or method among these. Some are solely transitional employers directed toward helping the individual to increase his skills and find a place in industry. Others are primarily interested in showing a profit. These are disinclined to let their good producers return to industry, which fosters dependency on the workshop. Some pay substandard wages. This is good for those who would otherwise have no employment, but does not create self-reliance in persons who might successfully compete. Still others[17,19] are partially subsidized and are not forced to meet competition to survive.

Several groups of impaired persons, such as Abilities of Hempstead, New York, and Paraplegic Manufacturing of Chicago, operate successful competitive businesses, employing only disabled personnel, paying them prevailing wages, and filtering them into industry.

An attitude of increasing appreciation of the value of handicapped workers has been reflected in their employment by a number of businesses in the past few years.[18,22] These companies have analyzed their jobs.[7] They analyze the man to determine what he can do, not of what he is incapable.[12] The man is then fitted into the job; this is the crux of the problem. Among manufacturers who have embraced this creed are General Motors Corporation, Ford Motor Company, Hughes Aircraft, AiResearch, Eastern Airlines, and Bulova Watch Company. These groups have found that properly placed disabled people make loyal, dependable, skillful, and profitable employees. The safety record of these individuals has consistently been better than that of industry as a whole.

This is good business for everyone. Whenever a handicapped person is made a productive employee, he becomes a taxpayer instead of a dependent. When a company rehires an injured worker, not only is his income restored, but the workmen's compensation for him is decreased and production is increased.

SUMMARY

Rehabilitation of the chronically disabled individual is a many faceted task which can best be accomplished by representatives of several disciplines working as a team.

The functions and skills which the patient retains must be strengthened and developed, since the level of his restoration and his work performance depend on these rather than on those he has lost. Physical, psychologic, educational, and surgical techniques are employed whenever they can increase any ability of the patient. Analysis of the skills needed for performance of specific jobs must be matched against the skills that the patient possesses in order to best place him in industry and re-establish his self-support. Closer cooperation between the medical rehabilitation team and personnel management is urged to make effective placement more general.

REFERENCES

1. Anderson, M.: Functional Bracing of the Upper Extremity, Springfield, Ill., 1958, Charles C Thomas, Publisher.
2. Campbell, H.: Pistol Attachment Device, Ortho. & Pros. Appliance J. **12**:62, 1958.
3. Comar, A. E.: Total Rehabilitation of the Spinal Cord Injury Patient, J. Indiana M. Prof. **4**:1928, 1957.
4. Herford, R., and Nickerson, S. H.: Relief of Pain and Rehabilitation of Chronic Arthritic Patients by Extended Sympathetic Denervation, Arch. Phys. Med. **40**:133, 1959.
5. Impaired, Employed, Insured (A Brochure), Association of Casualty and Surety Companies, New York.
6. Irvin, E. A.: Industrial Placement of the Physically Handicapped, Arch. Phys. Med. **37**:622, 1956.
7. Law, W. A.: Lumbar Spine Osteotomy, J. Bone & Joint Surg. **41B**:270, 1959.
8. Lowman, C. L.: Abdominal Fascial Transplants, Ann Arbor, Mich., 1954, Edwards Bros.
9. Lowman, E. W.: Self-Help Devices for the Arthritic, Institute of Physical Medicine and Rehabilitation, Bellevue Medical Center, New York.
10. Manual of Upper Extremity Prosthetics, Department of Engineering, University of California, Los Angeles, 1958.
11. Mazet, R., and Brooks, M.D.: The Prosthetic Team and the Child Amputee, J. Internat. Coll. Surg. **27**:70, 1957.
12. Melcher, R. D.: Employing the Seriously Impaired, Institute of Industrial Relations, University of California, 1959.
13. Nickel, V. L.: Functional Surgery in Patients With Severely Paralyzed Upper Extremities, Papers of the Fourth International Polio Conference, Philadelphia, 1958, J. B. Lippincott Company.
14. Nickel, V. L., Perry, J., Affeld, J. E., and Dial, C. W.: Elective Surgery on Patient With Respiratory Paralysis, J. Bone & Joint Surg. **39A**:989, 1957.
15. Nyquist, R. H.: Functions of a Physical Medicine Section for a Paralytic Service, Proceedings of the Second International Congress of Physical Medicine, Copenhagen, 1956.
16. Redkey, H.: Rehabilitation Center Concepts Change in Practice, Arch. Phys. Med. **38**:227, 1957.
17. Risch, F., and Rose, A. S.: Community Plan for Epileptics, Pub. Health Rep. **72**:813, 1957.
18. Risch, F.: A Scale of Employability for Handicapped Persons, O. V. R. Research Project #6457, Jewish Vocational Service of Chicago, Second Progress Report, July, 1958.
19. Rudd, J. L., and Feingold, S. N.: A Work Adjustment Center in Vocational Rehabilitation, Arch. Phys. Med. **40**:29, 1959.
20. Rusk, H. A.: Rehabilitation Medicine, St. Louis, 1958, The C. V. Mosby Company.
21. Selective Placement for the Handicapped, U. S. Employment Service, Department of Labor, Bulletin No. 923.
22. Sobin, S. S., Frasher, W. G., Alexander, C. A., and Horovitz, L.: Role of Work Classification Unit of the Los Angeles County Heart Assn., Arch. Phys. Med. **40**:161, 1959.
23. White, P. D., Rusk, H. A., Lee, P. R., and Williams, B.: Rehabilitation of Cardiovascular Patient, New York, 1958, McGraw-Hill Book Co., Inc.

Vol. 1
196

ol. 13
961

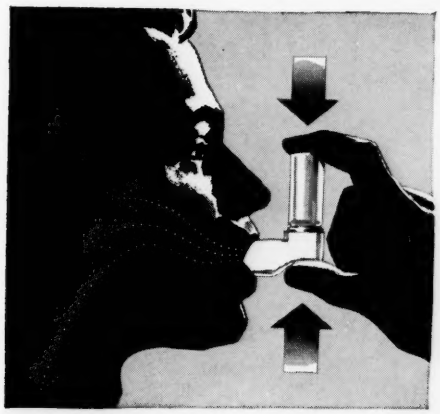
Optimal Asthma Relief

from smallest dosage...

in briefest time

Medihaler®

automatically controlled dosage by aerosol administration



22½% more vital capacity within seconds

The suspension of premicronized dry particles assures maximum delivery of the medication to the alveolar spaces where the therapeutic effect is exerted. The Medihaler suspension affords 5 times the bronchodilating power of the same medication in solution and approximately 20 times that of a squeeze bulb nebulizer.

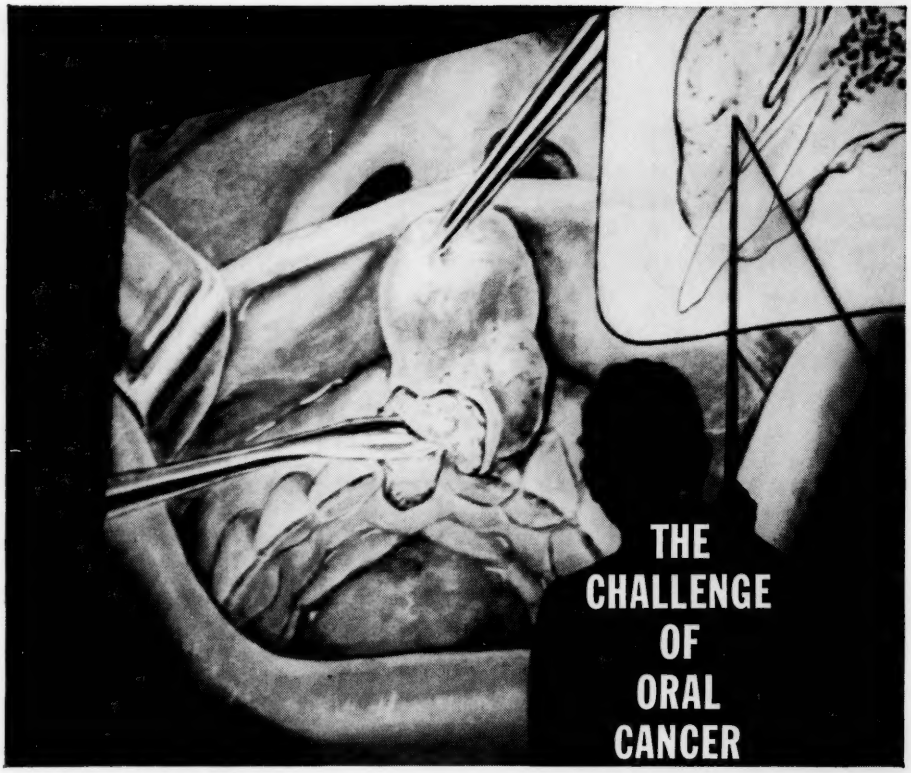
Medihaler is available with either of the two outstanding bronchodilating agents:

Medihaler-ISO® (isoproterenol)

Medihaler-EPI® (epinephrine)

NEW! 30 cc size vial for office or home

Riker Northridge, California



The curability of all cancer is primarily dependent upon its early detection, and prompt, adequate treatment. Oral cancer is relatively easy to diagnose at an early stage when successful treatment can be accomplished.

These are the facts: In one series of cases of oral cancer, the five-year cure rate for patients with both early and advanced lesions was only 32.5 per cent. In another series, consisting of patients with lesions *less than two centimeters* in size, the rate jumped to 57 per cent. The cure rate would even be *higher,* were all the lesions discovered when they were localized, and measured 1 cm. or less.

This is the challenge of oral cancer—to save lives and alleviate suffering through early diagnosis and prompt treatment. The American Cancer Society helps the dentist and his patient meet this challenge through its broad educational program stressing early diagnosis and treatment.

AMERICAN CANCER SOCIETY

ol. 13
961